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THE PENNSYLVANIA NEW YORK EXTENSION Railroad Co. was incorporated at Albany, N. Y., on Dec. 11, and, in connection with a New Jersey company under process of incorporation, is to tunnel under the Hudson and East Rivers and bring both the Pennsylvania and the Long Island railway systems to a terminal in Manhattan, somewhere in the neighborhood of 33d St. and 7th Ave. The incorporators are officers of the Pennsylvania R. R. Co., and President A. J. Cassatt of that company on Dec. 11 publicly announced the plans which have been matured for the construction of the work. The project is described on the editorial page of this issue. The following are extracts from Mr. Cassatt's statement:

It is now proposed to build a through underground connection between the Long Island R. R. and the Pennsylvania lines in New Jersey, and to construct a proper and commodious joint underground terminal station in New York city for the Pennsylvania and Long Island roads.

After years of exhaustive study, the conclusion has been reached that a tunnel line, operated by electricity, is in every way the most practical, economical and the best, both for the interests of the railroad company and of the city. The line as adopted will traverse the city of New York from the Hudson River to the East River and be underground throughout, and at such depth as not to interfere with future construction of subways by the city in all its avenues similar to the one now building along Fourth Avenue.

As the railroad will be wholly underground and operated electrically, in the same manner as the recently constructed Orleans Railway Extension in Paris, it will not be objectionable in any way. There will not be any smoke, dirt or noise, and as all the surface property may be built upon after being utilized underneath for railroad purposes, the neighborhood of the station will be improved instead of marred, as is so often the case when railroad lines are constructed on the surface or are elevated.

Immediately upon the necessary authority being granted the work of construction will proceed and the whole line be completed and put in operation as soon as possible.

THE HUDSON RIVER TUNNEL has been purchased by the North Jersey Street Ry. Co., which operates 240 miles of electric railway lines in the New Jersey suburbs of New York. According to published statements by Mr. E. F. C. Young, President of the North Jersey Co., the tunnel will be completed and used for through electric car traffic from outlying New Jersey cities to New York. Nothing has been done on the tunnel since 1892. The completed work consists of 3,915 ft. of one tunnel, built out from the New Jersey side, and 145 ft. of the same tunnel, built out from the New York side, leaving a gap of about 1,600 ft. to be filled. On the second tunnel about 550 ft. was built on the New Jersey end some twenty years ago. Approaches about 4,000 ft. in length on each side are required, on which nothing has been done. If the tunnel is completed as a double-track line (and nothing less would have sufficient traffic capacity to be worth operating), about 27,000 lin. ft. of tunnel will be required, of which only about 4,000 ft. has been completed.

CONTRACTS FOR A FOUR-TRACK STONE ARCH bridge over the Raritan, at New Brunswick, N. J., have been awarded by the Pennsylvania R. R. to H. S. Kerbaugh, Incorporated, of Philadelphia, Pa. This bridge is to be 1,500 ft. long and 57 ft. wide, and will have 21 stone-arched spans. It will occupy the site of the present iron bridge, but will be higher than that structure, so that the company can carry out its scheme for elevating its tracks through New Brunswick. So as not to interfere with traffic, one-half of the bridge is to be built first, and the present swing span will be ultimately dispensed with.

THE HAY-PAUNCEFOTE TREATY was ratified by the U. S. Senate on Dec. 16 by a vote of 72 to 6. The House Committee on Interstate and Foreign Commerce has reported favorably the Hepburn bill for the construction of a canal on the Nicaragua route "sufficient for the movements of ships of the greatest tonnage and draft now in use."

THE NEW YORK STATE CANALS carried 3,420,613 tons in the season of navigation just closed; a slight increase over 1900, when 3,345,941 tons was the total. The season of navigation was three weeks shorter in 1901, else a larger increase would have been shown.

THE YORK HAVEN WATER & POWER CO., now engaged in developing a water power on the Susquehanna River, below Harrisburg, Pa., is building the stone penstocks, retaining walls, etc., from plans made by The Robert Poole & Son Co., of Woodberry Station, near Baltimore, Md. This masonry will require about 1,600,000 cu. ft. of stone work, and will provide emplacement for 40 turbine water-wheels. These latter will operate 20 electric generators, of 750 K-W. each, generating a current of 2,400 volts, which will be transformed to 24,000 volts for transmission to the towns and cities within a radius of 12 to 15 miles. The order for the turbines and the transmission machinery for this power station has already been placed with The Robert Poole & Son Co., and it is expected that the plant will be in operation in the latter part of 1902.

THE CLEVELAND WATER-METER CONTRACT, involving 6,004 meters, with an option of 5,000 more of the smaller size, was authorized by the city council on Dec. 16, in accordance with the recommendation of Prof. Edw. W. Bemis, Superintendent of the water-works, and the approval of the board of control. The contract includes 5,000 ⅝-in. meters, including connections and cast-iron frost bottom, at $6.75 each; 800 ¾-in. meters at $9.45; 200 1-in. at $13.50; all of which will be supplied by the Neptune Meter Co., 253 Broadway, New York city. In addition, four 6-in. rotary piston meters will be bought from the Union Meter Co., of Worcester, Mass.

ROOFING THE EDEN PARK RESERVOIR of the Cincinnati water supply is reported as under consideration. The reservoir will receive filtered water when the new works are put in operation.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a butting collision on the Illinois Central Ry., near Perryville, Ill., on Dec. 15, between an eastbound passenger train and a westbound through freight train. A tank car filled with oil burst in the wreck and caused a fierce fire in the debris of the two trains. In the collision and the fire eight or ten persons were killed outright and five or six injured. Failure on the part of the conductor of one of the trains to obey orders is supposed to have been the cause of the wreck.——The wreck of a westbound train on the Great Northern Ry., near Essex, Mont., on the morning of Dec. 15 is reported to have caused the death of eight persons and the serious injury of at least a dozen others. Spreading of the rails is given as the cause of the wreck.——A steel bridge over Lycoming Creek, on the Pennsylvania R. R., near Williamsport, Pa., failed under a passing westbound express freight train on the morning of Dec. 15. The engine and nine cars went into the river and three of the train crew were killed. The bridge was comparatively new. It is thought that the high water had weakened one of the river piers and in this way brought about the collapse of the bridge.

EXTENSIVE DAMAGES FROM STORMS AND HIGH water are reported from the entire northeastern section of the country. The rains and storms of Dec. 14 and 15 caused nearly every stream in Maine, New York and Pennsylvania to rise to an extraordinary height, carrying away a great number of bridges, culverts, railway embankments, mills and power plants. Industry and communication were severely crippled throughout that region. Nearly every railway line passing through the afflicted districts suffered large losses, and railway traffic in many sections was completely tied up for from one to three days.

A 48-IN. CAST-IRON WATER MAIN BURST on Dec. 10 at Madison Ave. and 55th St., New York city. According to the engineer's report, the break was on the top of the pipe and was about 10 ft. long and 4 ins. wide in places, extending over two pipe lengths. The pipe was over ½-in. thick, and the water pressure was said to be about 25 lbs. to the sq. in. The edges of the break "curled over like tin." The only reason for the break that could be ascribed by Chief Engineer Birdsall, was some defect in the pipe, which was laid in 1873.

DRY DOCK NO. 2, AT THE NEW YORK NAVY YARD, which was recently rebuilt in concrete and which was reported in our issue of Nov. 28, 1901, to have become practically beyond repair, is still in use and the reports regarding its condition have been shown to have been erroneous. In a letter to Engineering News, Rear-Admiral P. C. Asserson, M. Am. Soc. C. E., Civil Engineer U. S. Navy, the engineer in charge of the work of reconstructing the dock in concrete, makes the following statement regarding the circumstances which gave rise to the erroneous accounts of the condition of the work:

In September, during my absence from the yard, the constant settling of the earth around the dry dock caused the breaking of a 15-in. sewer on the east side of and near the dock; this permitted the ebb and flow of the tide back of the concrete retaining wall. After a time seepage found its way through the layers and pores of the concrete retaining wall and showed itself on the face of the dock. As soon as the sewer was stopped the seepage disappeared, having done absolutely no harm whatever. On the west side tide water gained admittance to the back of the retaining wall through some old and decayed sheet piling that had been left from the old wooden dock with the same result as on the east side. The driving of a few sheet piles and calking some of the old sheet piling back of the abutment, so as to cut off the tide water from the side of the structure, have stopped the seepage and no harm has been done to the dry dock structure, which is as good and solid to-day as it was the day it was finished.

THE TORPEDO-BOAT DESTROYER "DECATUR," built by Trigg, of Richmond, Va., is the first completed of the 16 vessels of this type authorized. On Dec. 12, after some preliminary runs for standardizing her screw, she made a two-hour run over the Chesapeake Bay course at the rate of 28.135 knots. This was accomplished with only 220 lbs. steam pressure and 50 tons more load than required by contract. With full boiler pressure she should easily make 30 knots.

PROJECTS FOR PERMANENT SEACOAST DEFENCES in the United States, says the Chief of Engineers, in his last report, have been adopted for 31 localities on the Atlantic, Gulf and Pacific coasts. This modern system of defences dates from 1890; and the system is now 50% completed with 25 principal harbors sufficiently armed with heavy guns and mortars to permit an effective defence against naval attack. The present project contemplates the mounting of 464 guns of 8, 10, 12 and 16-in. caliber, 1,041 rapid-fire guns from 6 pdrs. to guns of 6-in. caliber, and 704 mortars, at a total approximate cost for engineering work of $50,000,000. Since Aug. 18, 1890, Congress has appropriated for the construction of these gun and mortar batteries, $23,757,000, not including $306,506 expended during the late Spanish war from the appropriations for "National Defence." At the present time provision has been made for emplacing 325 heavy guns, 387 rapid-fire guns and 376 12-in. mortars, out of the total above. With a tendency toward a reduction in the caliber of heavy guns, coupled with the adoption of a disappearing carriage for the 12-in. gun, the United States has never embarked upon the construction of armored casemates and turrets, to which so many European nations now stand committed.

THE CORPS OF ENGINEERS, U. S. A., says the last report of the Chief of Engineers, Brig. Gen. G. L. Gillespie, numbered 131 officers on June 30, 1901. But by the Act of Feb. 2, 1901, the corps now numbers 160 officers, and in addition there are three battalions of four companies each, of enlisted men. Each of these companies contains 100 men on a peace footing, and 164 men in time of war. This increase in officers and men is made necessary by the new possessions of the United States; as on June 30, 1901, 32 officers of the Corps and eight companies of engineer battalions were on duty in the Philippines, China, Cuba, Porto Rico and Alaska.

THE ARMY OF THE UNITED STATES, says the Secretary of War in his last report, now numbers 3,253 officers and 76,084 enlisted men; this does not include 4,336 men in the Hospital Corps, 172 volunteer surgeons in the Philippines, 4,978 native scouts under the command of 98 officers in the Philippines and 850 men in the Porto Rico provisional regiment. Secretary Root approves the recommendation of the Board of Visitors to the Military Academy for a complete renewal of the buildings there, to make them conform to modern ideas of sanitation and comfort.

THE ORENSBURG-TASHKENT RAILWAY is to be built under an imperial ukase just issued ordering its construction. Its completion would relieve the famine-stricken population of Eastern Russia, reach the rich salt mines of Iletzki and give employment to the iron works of this section. Orensburg is on the Ural River, on the extreme East boundary of European Russia, and the terminus in that direction of the Russian railway system. The proposed railway would run southward towards the Caspian Sea, to Kazalinsk, and thence southeast through Perovsk and Turkestan, toward Tashkent. The railway would be 1,068 miles long, and generally traverse good farming land and the fertile valley of the Syr-Daria with a population of 1,500,000 and a trade amounting to $25,000,000 per year. Tashkent is on a branch of the Syr-Daria River, and northeast of Samarkand, on the Trans-Caspian Railway; but a range of mountains intervenes.

SOME INTERESTING FEATURES OF RECENT CHIMNEY CONSTRUCTION.

(With two-page plate.)

The establishment of manufacturing plants of great size and capacity, and the concentration of power and electric generating machinery into large central stations, have led to a great development in tall chimney construction. In a large number of cases these chimneys are of steel, which has the advantage of more rapid erection and economy in first cost as compared with a brick chimney. In the present article we describe three large chimneys of this type, each of which has interesting features of its own, and also a recently built concrete-steel chimney.

STEEL CHIMNEYS FOR THE ST. LOUIS TRANSIT CO.

The electric current for operating the consolidated street railway system of the St. Louis Transit Co., at St. Louis, Mo., is generated at two large power stations (which we shall describe and illustrate in detail in a later issue), and each of these stations has a self-supporting steel chimney 202 ft. high from the top of the concrete foundation, and 14 ft. inside diameter. These chimneys are exactly alike, having been built from the same plans, the principal parts of which are reproduced in Fig. 1. The special feature in the design is that the courses are put together with butt joints for the circular seams, spliced with inside and outside welt rings (double riveted to each course); with this construction there is no shear on the rivets, the weight being carried directly through the shell to the foundation. The ¼-in. plates at the top, however, have only outside welts. The shell plates are 6 ft. high, and vary in thickness from 5/16-in. to ¼-in.; each course has a single vertical seam, double riveted.

The cap is built up of steel plates, cut to give the required shape, as shown. The bottom section, 16 ft. high, flares out in a trumpet shape to a bottom diameter of 21 ft., and it is noted that in spite of the number and the rather complicated arrangement of the rivets in the vertical joints of this section, the plates fitted together with little or no reaming, showing great care and accuracy in laying off and drilling the work. Riveted to the base are 12 brackets for the attachments of the 12 anchor bolts, which are 3 ins. diameter and 20 ft. long. The field riveting was done with pneumatic jaw riveters, as shown in Fig. 2. The total weight of metal in each chimney is 300,000 lbs.

The chimney is lined with fire brick to a height of 53 ft. The smoke flues enter oval openings in the chimney 7¼ × 14 ft., the shell being reinforced at each of these large openings by a heavy flanged ring and an angle-iron ring. A vertical steel baffle plate in the center of the chimney, and fronting the flue openings, prevents any interference of the currents entering on opposite sides.

These chimneys were designed by W. D. Boyce & Co., Chemical Building, St. Louis, Mo., who were the consulting and supervising engineers for the power stations of the St. Louis Transit Co. The contract for their construction was awarded to the O'Brien Boiler Works Co., of St. Louis, Mo.

STEEL CHIMNEY OF THE ELECTRIC LIGHT PLANT AT CINCINNATI, O.

One of the interesting features of the main plant of the Cincinnati Gas & Electric Co. is a steel chimney supported upon columns, and which, instead of being a plain cylindrical or tapering shaft, is built in the form of a pillar, having a curve of entasis, or convex curved taper, as shown by the view, Fig 3. The top of the chimney is 200 ft. above the level of the boiler room floor, but the steel shell is only 146 ft. 6 ins. high. The lower part, below the smoke flues, is not required for the purposes of a chimney, and if built as a steel shell it would simply be an obstruction in the boiler room, the chimney being located in the middle of this room, with an economizer on each side, from which the flues enter the chimney.

Four steel columns extend from pedestal foundations of I-beams and concrete to a height of 62 ft. 6½ ins. above the basement floor, being connected by horizontal members and vertical knee bracing. At the top these columns support four box girders, two 5 ft. and two 4 ft. high, with 3-ft. plate girders connecting them diagonally to form an octagonal frame. From the floor above the boiler room a brick-lined shell is built between the columns, the bottom of the shell being curved to allow the passage of a 50-in. steel pipe, as shown in the detail drawings, Fig. 4. The flues from the boilers enter here by arched openings, while the flues from the economizers enter at the floor above, through iron-framed rectangular openings 8 × 13 ft. in the clear.

The shell proper starts from a base on the rectangular framework above the [illegible] ring being secured to the lower co[illegible] plating by 16 gussets. The courses [illegible] high in the exposed portion, exclusive of the lap

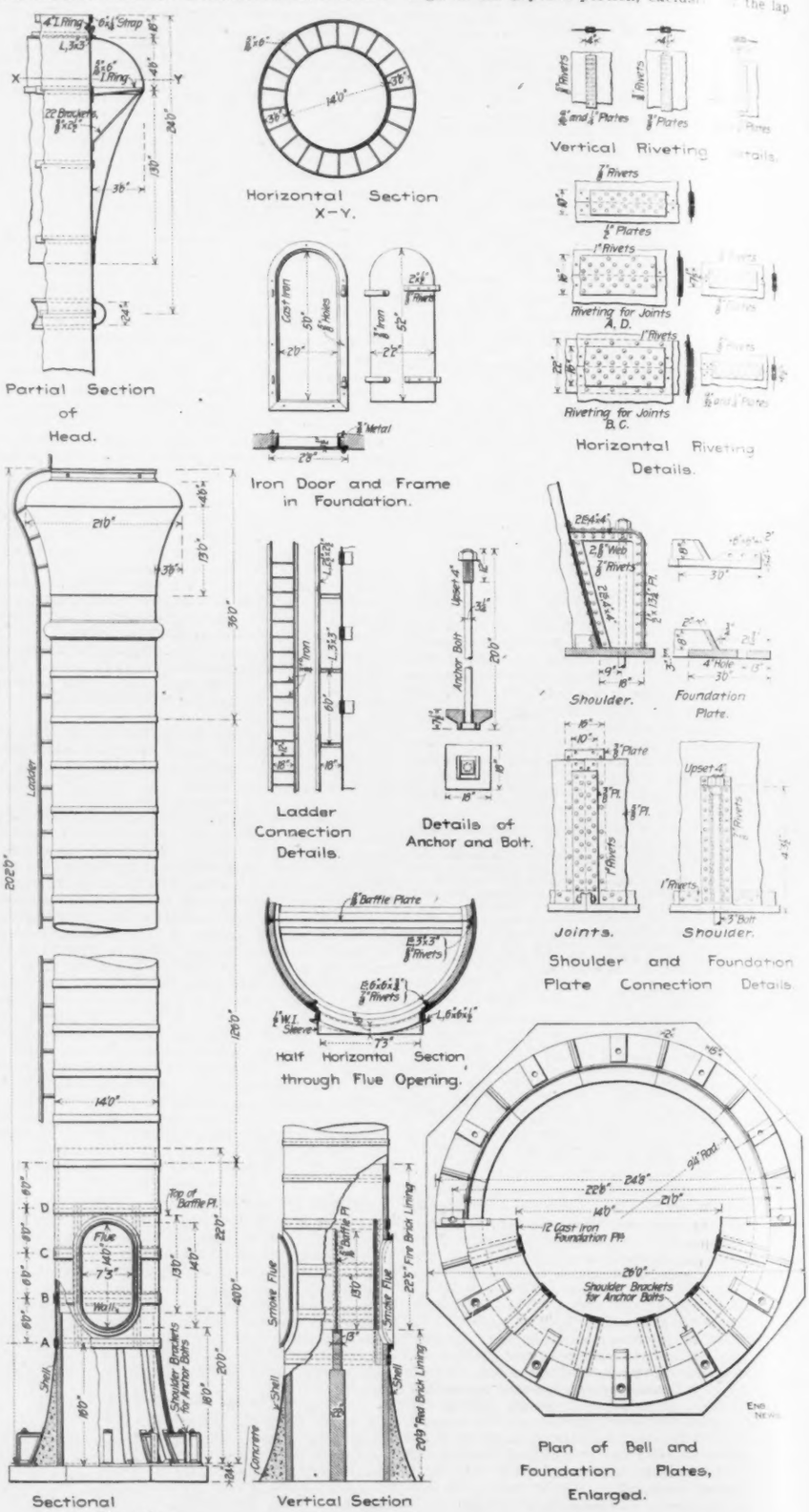

FIG. 1. STEEL CHIMNEYS FOR THE POWER STATIONS OF THE ST. LOUIS TRANSIT CO.
W. D. Boyce & Co., St. Louis, Mo.; Consulting Engineers.
O'Brien Boiler Works Co., St. Louis, Mo.; Builders.

joints, and the length of the plates is one-fourth the circumference of the shell. The courses are alternately inside and outside, with triple riveted circumferential seams for the first six courses, double riveted in the next nine courses, and then single riveted to the top. All rivets are ¾-in. diameter. The vertical seams are double riveted and have inside splice plates or welts of the same thickness as the shell. The thickness of the shell plates is 7-16-in. for four courses, ⅜-in. and 5-16-in. for seven courses each, and then ¼-in. to the top. The ornamental cap extends above the shell, and has a steel frame, covered with sheet steel, while the molding below the cap is of galvanized iron. The top of the chimney is 200 ft. above the level of the grate bars.

The diameter of the shell is 20 ft. 4 ins. at the base, and 20 ft. at a height of 48 ft. 7¾ ins.; above this point the diameter of the shaft diminishes with a convex curved taper, the diameter of shell at the top being 16 ft. 10 ins. This peculiar construction involved considerable work in cutting and punching the plates to the exact form required to give the proper vertical curve or entasis. For a chimney of such large diameter, however, the builders do not believe there would be a great difference in cost between a curved contour or a plain taper. In both cases specially shaped plates and special punching would be required, and the curved form would probably not make more than 5% or 10% difference in the cost. With a small chimney, however, the adoption of the curved form would probably make a material difference in the cost.

Fig. 2. Method of Erecting and Riveting Steel Chimney for the St. Louis Transit Co.
(The oval openings are for the smoke flues and the brackets at the base are for the anchor rods.)

The chimney is lined with fire brick from top to bottom, the lining of the circular shell being carried independently of that between the columns. The thickness of the brick work is 13 ins. at the base, reduced to 9 ins. and then to 4 ins., the inside diameter at the top being 16 ft. Concrete backing is filled in between the steel shell and the brick lining.

This chimney was designed by Mr. A. O. Elzner, of Elzner & Anderson, Cincinnati, O., the architects for the power station. It was built by the L. Schreiber & Sons Co., of Cincinnati, O.

In the general view of the power station and chimney, Fig. 3, will be noticed a heavy built-up steel post carrying cross-arms for the wires. This post forms a conduit for the cables which lead out underground and up through the post. This station is located on the bank of the Miami & Erie Canal, water from which is used for condensing purposes, and one of the cooling towers is shown at the back of the chimney. The station was built for the Cincinnati Edison Electric Co., and is now the main power station of the consolidated Cincinnati Gas & Electric Co. It was planned with a central boiler room and an engine room on each side, but only one engine room was originally built. The new company is now arranging to enlarge the plant by building the other engine room, at the left of the view, which will make the structure symmetrical in appearance. The building is of steel frame construction, and the necessary brackets and connections for the extension were attached to the columns when first constructed.

STEEL CHIMNEY WITH RADIAL WIND BRACING.

A large proportion of self-supporting steel chimneys have the base of the shell extended in conical or trumpet shape form to give an enlarged base to resist wind pressure, but in the style of chimney illustrated in Fig 5 the shell is cylindrical throughout, and is supported by six vertical triangular braces having the vertical leg riveted to the chimney shell while the base is anchored to the foundation. This arrangement gives a much better resistance to wind pressure, the chimney being supported laterally at a considerable height above its base. The trusses and foundation are so designed that the resultant of strains due to wind pressure falls within the middle third of the foundation. This system of construction was designed by Mr. J. F. Jackson, Assoc. M. Am. Soc. C. E., of Houghton, Mich., who is engineer of the Wisconsin Bridge & Iron Co., of Milwaukee, Wis., and this company has built several chimneys on this plan. Mr. Jackson considers that the stability, simplicity of construction, draft efficiency, durability, and low first cost of brick-lined, self-supporting chimneys of this construction, are such as to recommend them for general use for boiler plants of medium or large size.

The details, of course, vary with the size of the chimney, but the accompanying illustration, Fig. 5, shows a steel chimney, 10 ft. clear inside diameter and 160 ft. high, built for the stamp mill of the Osceola Consolidated Copper Co. at Houghton, Mich. The diameter of the shell at the base is 12 ft. 2 ins., and there are six radial braces 30 ft. high, while the vertical leg of each brace extends 25 ft. higher. The base width of each brace is 11 ft. The vertical and inclined legs and all the web members are composed of pairs of angle irons, as shown on the drawings, heavy connection plates being used at the panel points. The braces are fitted to the angle iron base ring of the chimney. At the base is a ⅜-in. web plate carrying the attachments for two of the twelve anchor rods. These rods are 1¾ ins. diameter, with upset ends, and are about 20 ft. long. The brick foundation is 20 ft. high, hexagonal in plan, with a diameter of 26 ft. at the base and 20 ft. at the top, the top being covered with a few inches of concrete, as shown, sloped to shed water. The flue opening in this portion is 7 ft. 4 ins. wide and 9 ft. 6 ins. high to the springing line of the semi-circular arch.

The shell is telescopic, each course of 5-ft. plates being set inside the one below. The circular and vertical seams are single riveted, and are made with lap joints. At the base are two angle iron rings, one on the outside of the shell and the other carrying the brick lining, both being riveted to the ⅜-in. base-plate ring. Twelve ⅜-in. bars, 6 ft. long, form inclined inside braces, being riveted to the back of the inner angle iron ring and to the bottom of the second course of shell plates. The shell is ⅜-in. thick for a height of 50 ft., then 5-16-in. for 60 ft., and ¼-in. for 50 ft., the top being fitted with an outside angle iron and flat plate ring. At intervals there are angle iron rings on the inside of the shell. These support the brick lining, which is double to a height of 54 ft., and thence single to the top. An iron ladder is provided in the usual way.

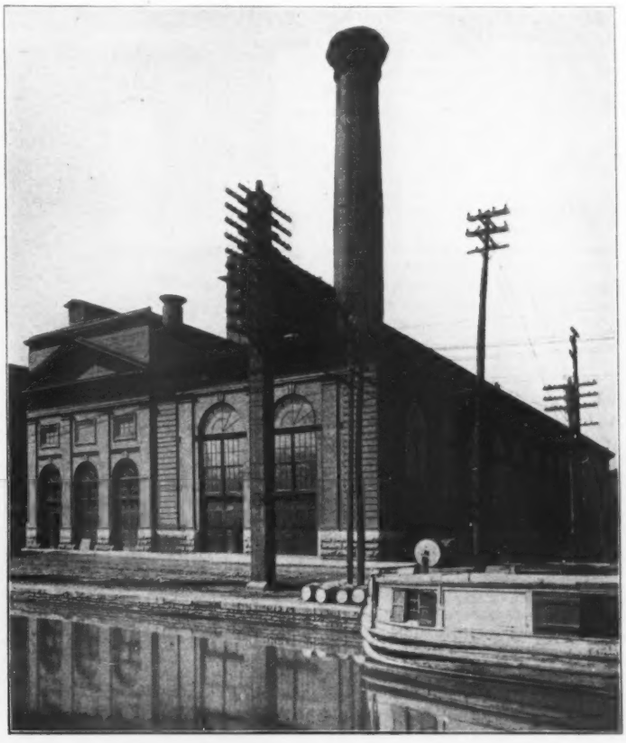

FIG. 3. PILLAR-SHAPED STEEL CHIMNEY; CINCINNATI GAS & ELECTRIC CO.
E. O. Elzner, Designer.
L. Schreiber & Sons Co., Builders.

In the erection of these chimneys a rectangular gin-pole frame or tower is built up inside. This tower has four timber posts, 2 × 4 ins., and board bracing. It is carried up 25 or 30 ft. at a time, without guy lines, so that four or five courses can be built, the plates, brick, etc., being handled by a derrick on the working platform of the tower. When the chimney is completed the tower is frequently set on fire, it not being worth while to go to the trouble of taking it down and removing the timbers, which would in many cases be a matter of difficulty.

STEEL CONCRETE CHIMNEY WITH SEPARATE LINING.

A number of novel features are embodied in a chimney built during the past year for the Central Lard Co., at 17th and Cole Sts., Jersey City, N. J. The chimney is constructed of concrete, reinforced with cold-twisted steel rods according to the Ransome system. It has an inner fire lining constructed of steel and concrete like the remainder of the structure. The concrete used is made with crushed trap rock, and no sand is used with the cement, the finer particles of the crusher product being counted on to take the place of sand. The location of the chimney is in deep marsh soil, which called for special attention to the foundation work.

The completed structure is shown in Fig. 6, as erected adjacent to the factory buildings of the Central Lard Co. Fig. 7 shows vertical elevation and section and horizontal sections at different points, and gives the principal dimensions. The stack is 108 ft. high above top of foundation, and is cylindrical in form (i. e., with no taper), with inner and outer diameters of 8 ft. and 11 ft. 4 ins. respectively. The shell is double, an annular air-space separating the inner and outer shells. At 8 ft. below finished grade the shaft expands into a spread base or footing resting directly on the foundation piles. At the top an ornamental molded cap of concrete strengthened with steel is provided.

The soft marsh soil at the site of the shaft extends to a depth of at least 50 ft. below foundation level. To form the foundation 56 piles were driven through this soil and several feet into hard pan, a total depth of about 55 ft. Since under these conditions it seemed probable that the piles would act to a great extent as columns, it was considered advisable to limit the maximum total load on each pile to 7½ tons; this fact accounts for the relatively large number of piles used in the foundation. The piles were cut off level and concrete was rammed around their heads 18 ins. deep. Around the outer piles two circumferential rods were embedded in the cement to prevent spreading of the piles or cracking of the foundation concrete.

The base proper of the stack is a mass of concrete 3 ft. in thickness formed right on the pile foundation. Embedded in its mass just above the pile tops are steel reinforcing rods arranged in four layers crossed on each other. Fig. 7 gives a plan view of the base, showing the arrangement of these rods and of the foundation piles.

The stack rises directly from the concrete base; the bottom of the flue is, however, located at a point 8 ft. higher, and the ground around the chimney will be filled in to this level. For this lower 8 ft. the walls of the stack are solid, 20 ins. thick, and the hollow interior of the chimney is filled with stone, topped off with a concrete floor at the level of the bottom of the flue. Above this point the walls are double. The inner shell or flue lining has a vertical wall 4 ins. thick; the outer shell varies in thickness from 7 ins. at the bottom to 4 ins. at the top, its inner face being stepped off for this purpose. Both shells are throughout strengthened by twisted steel rods arranged both vertically and circumferentially, as indicated in the drawing. A flue opening 5 × 10 ft., is formed in the front of the stack and has ten ¾-in. bolts set in its flange for the attachment of the steel smoke flue. At ground level is a clean-out opening similarly formed in the stack. The air space between the two shells of the stack has seven 1½-in. vent holes at the bottom to permit of free air circulation for cooling the lining. For the same reason and also to allow for expansion a 4-in. space is left between the top of the inner shell and the cap of the chimney.

The method of constructing the shaft was as follows: An interior scaffolding was carried up a little in advance of the chimney. From this the molds for the inner and outer face of the wall were suspended by threaded rods passing through hand wheels at their upper end. Each mold was a complete ring of pine boards, properly cleated, and having a vertical joint at one side fitted with sheet iron lap-plates. Turnbuckles at the joint were provided to slightly open or close the ring. The air space between the shells was produced by collapsible boxes provided with meeting tongues at their ends; the boxes themselves were kept some inches apart, and thus the buttresses on inner and outer wall were formed that are shown in the sections. The tongues at the same time formed a complete division between the two shells, so that separate expansion might freely take place.

The chimney was constructed in 5 ft. sections. The molds were 12 ft. high, giving a 7-ft. lap on the previous section to guide the work straight. The concrete used was made of one part of Atlas Portland cement and five parts broken stone; this broken stone was crushed trap, the whole crusher product under ¾-in. being used. The concrete was mixed quite wet in a Ransome mixer, and after being put in place was thoroughly rammed. When one section was completed the molds were loosened by means of the turnbuckles and then raised up 5 ft. by screwing on the hand wheels; the molds were then tightened up again and another section begun.

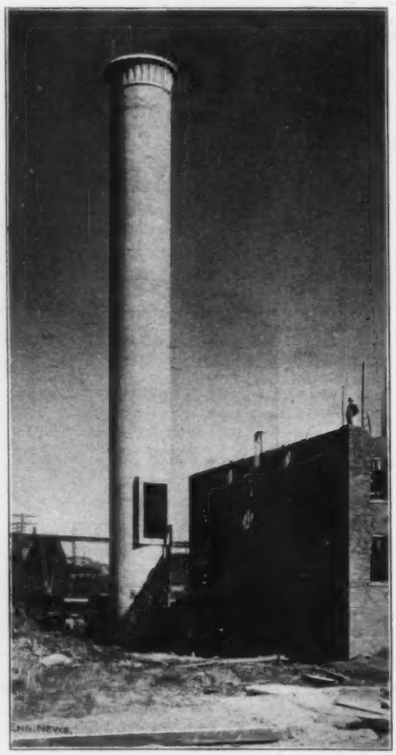

Fig. 6. Steel-Concrete Chimney of Central Lard Co., Jersey City, N. J.
Designed by Ransome Concrete Co., New York, N. Y.

In forming the wall around the flue opening a rough opening was left out as the wall construction went up. The finished frame with its flange was later molded in place, of concrete, and tied to the main shell. The ornamental cap was cast on the ground in 26 sections, and these were set in place on the chimney and cemented together; a twisted steel tie was also placed around the top as additional security. Four of the vertical rods in the outer shell were carried up continuously from the ground to the cap and allowed to project at the top a distance of several feet. They were well grounded at the bottom and tipped with copper at their upper ends to act as lightning conductors for the chimney.

No special care was taken to keep the stones in the concrete from the face of the work, but the wet condition of the mixture and thorough tamping were relied on for this. The surface obtained was satisfactory, but to obliterate the roughnesses left by the boards of the mold the whole outer surface of the chimney was bush-hammered after the work was completed.

The calculations assumed a wind pressure of 25 lbs. per sq. ft. of vertical projection. The maximum unit stress in the concrete is 35[illegible] per sq. in. compression. The amount of conc[illegible] used in the construction of the chimney was [illegible] al of 4,974 cu. ft.; of this 1,460 cu. ft. were [illegible] the foundation and 3,514 cu. ft. in the sta[illegible] itself. The twisted steel rods used weighed 8[illegible] lbs. From these figures the total weight of t[illegible] imney, at 144 lbs. per cu. ft. for the con[illegible], is found to be about 362 tons. The contr[illegible]rice paid for the chimney was $3,500.

The chimney was completed in August [illegible] this year. It was built by the Morris Buildi[illegible] Co., licensees of the Ransome Concrete Co., aft[illegible] plans furnished by the parent company. Mr. [illegible]ry Floy was consulting engineer to the own[illegible] the Central Lard Co.; Mr. H. C. Turner is [illegible]neer for the Ransome Concrete Co., while Mr. [illegible] H. Dixon was in charge of the construction [illegible] the Morris Building Co.

STANDARD CAR-TRANSFER BRIDGE; N. Y. CENTRAL & HUDSON RIVER R. R.

(With two-page plate.)

The insular position of New York city with respect to the terminals of the great majority of the railways which terminate there, has resulted in the development of one of the most extensive systems for transferring cars on floats which exists anywhere in the world. As most of our readers know, the structure by means of which cars are safely and expeditiously transferred between the terminal tracks on shore and the floats which convey them about the harbor is the transfer bridge, which has thus become one of the most characteristic structures of the New York water front. Theoretically the transfer bridge offers little that is difficult to the structural designer, but its practical adaptation to the hard service which it has to endure and to the varying conditions of this service is a problem requiring considerable study. This fact will be readily appreciated if it be remembered that the car float, like any other vessel, rises and falls with the tide and tilts and rocks with changes in loading and with unequal loading, and also that the transfer bridge has to adapt itself to these variations and at the same time preserve the rigidity necessary to carry safely the heavily loaded cars which are to be transferred between the float and the shore tracks. The chief difficulty arises in taking care of the torsional strains which come from the tilting of the float when one side is loaded or unloaded before the other. To remedy this trouble the New York Central & Hudson River R. R. has adopted as standard the design and construction for transfer bridges which are shown in the accompanying drawings.

To understand the new features of this bridge, a brief reference to the older and more common construction of transfer bridges is necessary. As a rule such structures consist of a two or three-truss bridge (usually a through wooden truss structure) hinged horizontally at the shore end to a fixed abutment and carried at the opposite end on a floating pontoon. The pontoon end is usually further supported and steadied by a gallows frame having sheaves over which cables pass with one end connected to the bridge platform and the other end wound on the drum of a hand winch mounted at one side of the bridge. While bridges of this construction adapt themselves well enough to the rise and fall of the car float with the tide, the common experience has been that the severe torsional strains which they undergo necessitate frequent and expensive repairs to maintain the structure in working order. The new standard bridge has been designed to remedy this difficulty, and it accomplishes this remedy by employing an apron as an intermediate link between the bridge proper and the car float, instead of fastening the float directly to the bridge. In this construction there is, of course, a torsional strain upon the apron platform. This is not done away with, and cannot be. The advantage, however, of the new bridge over the older form exists in the fact that the distortion occurs in a light easily repaired, flexible portion of the structure whereas with the pontoon bridge the torsion injures and causes extensive repairs to the main trusses. Stated briefly, the new form of bridge

localizes the distortion where it does the least damage.

The construction of the new bridge is shown by the accompanying drawings. The longitudinal section, Fig. 1, shows the relative arrangement of the bridge proper and its connecting apron and of the gallows frames and hoisting mechanism which carry their suspended ends. The bridge proper is a three-truss combination structure, forming a rigid platform for the double railway tracks. At its inshore end this platform rests on a horizontal hinge, constructed as shown by the detail drawing Fig. 2. The outshore end is held suspended by the mechanism shown by the sections A A and B B in Fig. 1. This mechanism consists essentially of two sets of counterweights and of a set of three vertical screws operated by worm gearing on a horizontal transverse shaft. Fig. 3 shows the enlarged details of the connections between the bridge platform and the suspension rods and cables. The outer end of the bridge is kept at a uniform height above the water by this machinery, which is operated by either gasoline engines or electric motors located at one side of the bridge at its outer end.

The location of the apron platform is shown by the longitudinal section, Fig. 1. Fig. 4 shows a side elevation of this apron, and Fig. 5 is a part plan of the outer end. At its inner end the apron is hinged to the bridge platform, while at its outer end it is held by suspension cables passing over overhead pulleys and counterweighted, and by hoisting cables which wind on the drum of a windlass, as shown by the part transverse section at C C, Fig. 1. The outer end of the apron is connected with the float by toggles, and is thus enabled to rise or fall with the float during the loading or unloading of cars, while the main bridge remains stationary. The tracks at the outer end of the apron are adjusted to the varying positions of the tracks on the float by means of the rachet screws shown by Fig. 5. Further details of the structure and the operating mechanism may be obtained from the drawings Figs. 1 to 5.

The information from which this description has been prepared was furnished us by Mr. W. J. Wilgus, M. Am. Soc. C. E., Chief Engineer, New York Central & Hudson River R. R.

THE COST OF OPERATING MECHANICAL FILTERS AT EAST PROVIDENCE, R. I.

Some details of the cost of mechanical filtration at East Providence, R. I., have been secured, at our request, by Mr. Edmund B. Weston, Am. Soc. C. E., of Providence, R. I. These may be considered as supplementary to the analytical results, supplied by Mr. Weston, published in our issue of Dec. 5. Mr. Weston informs us that he doubts the practical value of the figures, but as he obtained the best figures available, and as the data on this subject are so limited, we print the figures for what they are worth. Mr. Weston says:

> The cost of operation of the East Providence filter during the last year can only be roughly estimated. The power required for driving the wash-pump and agitator is furnished by a water turbine, and the value of the water used, etc., would be difficult to estimate. The filtered water is pumped directly into the mains, and the pump in the pumping station which is used by far the greater part of the time, is also driven by water power. The filter plant is located directly adjacent to the main pumping station.
>
> The pumping station and filter plant are in charge of one engineer who does all of the work required in the daytime, including the operation of the filter, and all ordinary repairs that are necessary. There is also one man on duty at night who looks out for the pump and filter, but there is generally very little work done at night in connection with the filter.
>
> The engineer in charge of the pumping station and filter plant has just informed me that an average amount of 254,000 gallons of water per 24 hours has been used during the past year, and that the expense of the labor employed for the filter plant he estimates to be about 50 cts. per 24 hours.
>
> From these figures, I have computed that the cost of operation per 1,000,000 gallons was $1.95. As one grain of sulphate of alumina was used per gallon, I have estimated the unit cost of sulphate of alumina (at $1.25 per 100 lbs.), together with the cost of water for washing and waste (5% of the amount filtered) to be $1.88 per 1,000,000 gallons, making a total cost of $3.83 per 1,000,000 gallons.

Of course, it is difficult to figure the cost of filtration at works operated in conjunction with a pumping plant, as this one is, particularly where the only records kept appear to be the amount of water pumped.

BOOK REVIEWS.

CRAM'S ATLAS OF THE WORLD, ANCIENT AND MODERN.—New Census Edition, indexed. A thoroughly revised, rewritten and newly illustrated edition. By George F. Cram, editorially assisted by Dr. Eugene Murray-Aaron, F. E. S., F. Z. S. E., etc. Published by George F. Cram, 130 Fulton St., New York, and 61-63 Plymouth Place, Chicago, Ill. Boards, 11¾ × 14¾ ins.; pp. 864, with diagrams, charts and over 300 half-tone views of choicest scenery. Cloth, $10.00; half morocco, $12.50; full Russia, $15.00.

This atlas has many new features to commend it. Besides presenting excellent maps of the political divisions of the world and the principal cities, astronomical charts and ancient and classical maps, it is a universal gazeteer of practical reference. An index of over 300,000 places enables each country, state, island, city, town or village to be easily and quickly located. The spelling of place names is that adopted by the U. S. National Board on Geographic Names and the Royal Geographical Society of England. Statistical diagrams and tables, compiled from the latest figures, give the products, population, governments, industrial and railway growth, distances and comparative time, naval and merchant marine, debts, etc., for all the principal countries of the world. And other charts, diagrams and text treat of astronomy; ancient, classical and historical matter; chronology, geography and history of the United States in periods of time; the political parties of the United States, with political platforms from 1789 to 1901; science and industry, and miscellaneous matter covering a great variety of subjects. In connection with the maps of states and political divisions of the world any especially important section is shown on a larger scale, and a concise history is given for each of the United States, South American and European divisions, treating of its physical features, government, principal products and industries, etc. A large number of very good half-tones illustrate this part of the work. In a word, the atlas makes good its claim that it is the greatest work of its type placed before the public.

ELECTRICAL ENGINEERS' POCKET-BOOK.—A Handbook of Useful Data for Electricians and Electrical Engineers. By Horatio A. Foster, M. Am. Inst. E. E., M. Am. Soc. M. E., with the collaboration of eminent specialists. New York, 1901: D. Van Nostrand Co. Leather flaps; 4½ × 7 ins.; pp. 987; illustrated. $5.

We know of no better way by which to convey to our readers a notion of the scope, character and appearance of this book, than to say that it resembles closely in all of these features the well-known pocket-books of Trautwine and Kent. What Trautwine is for the civil engineer and what Kent is for the mechanical engineer this book bids almost certain to be for the electrical engineer. To attempt to review critically the multitude of subjects treated would be an impracticable task and to give a list of section headings would be to occupy time and space to little practical purpose. We will, however, endeavor in another way to give the possible and, we hope, soon to be purchaser, a general idea of the book, which, in return for his five dollars, will be added to his library shelves. In size, binding, paper and typography the book resembles closely Kent's pocket-book, the binding, however, being in blue instead of black leather. Compared with Trautwine, therefore, it is about ¼-in. taller and has a size larger type; in binding, blue leather replaces the brown leather of Trautwine and a flap scarcely more than two-thirds as wide is used. It is a minor feature perhaps, but, nevertheless, one worth of commendation, that the publisher selected a color of leather different from that of the two other pocket-books with which the new book will, in most engineers' libraries, stand side by side on the shelves, and from which its distinction to the eye must depend largely upon a distinctive color of binding. Turning now from externals, it may be noted that the author, whose work the compilation chiefly is, is well known both as a contributor to technical literature and as a practicing engineer of reputation. However broad his individual experience may be, nevertheless, it is clear that no one man can treat expertly all branches of electricity and electrical engineering. This plain fact has been recognized by the author, and in preparing his book he has brought to his aid the active collaboration of a number of specialists, to whose critical examination all parts of the text have been submitted. It is inevitable that this procedure should produce a work of wider scope and higher authority than would result from the uncriticised and unaided work of one person.

Turning now to the actual results of this collaboration in the book before us, it can be stated at once that the book is not an encyclopedia nor is it a text-book, but it is intended to be and to our notion succeeds in being a compendium of useful facts for the daily use of the electrician and electrical engineer. The man who knows nothing of electricity will not find in the book a source of knowledge of the rudiments of this science; he is assumed to be equipped with this elementary knowledge before he uses the book. Neither will the man who is looking for a theoretical discussion of principles and phenomena find it here. What he will find, in such measure and with such accuracy as it is reasonable to expect, will be the developed formulas and constants and the descriptive facts which our modern knowledge of engineering and electricity has to present. As the field of electrical engineering overlaps to some extent the fields of both civil engineering and mechanical engineering, it was necessary for the author to devote some space to these branches, and this he does in the concluding 200 pages of his book. In conclusion we can only repeat our suggestion that every engineer who has anything to do with electricity in its various applications to engineering works should possess himself of a copy of this book.

THE STANDARD SPECIFICATIONS FOR CAST-IRON PIPE PROPOSED BY THE NEW ENGLAND WATER-WORKS ASSOCIATION.

In our issue of Dec. 5, we published the report of a committee of the New England Water-Works Association on "Standard Specifications for Cast-Iron Pipe." The following is an abstract of the discussion of the report at the meeting of the association at Boston, Dec. 11:

A written discussion from Mr. Emil Nuebling, Superintendent of the water-works of Reading, Pa., endorsed the plan of making the outside diameters uniform for given inner diameters, and asked why it could not be extended to large sizes as well as small, suggesting that a simple special to connect standard pipes with old pipe already laid could be readily devised. He also suggested that the lead space be made less. Mr. F. A. McInnes, of the Boston city engineer's department, suggested that chemical and microscopical tests be incorporated in the specifications. Representatives of the pipe manufacturers said that they were in hearty accord with the greater part of the specifications, but as they had not had time to confer with one another, they were not ready to make any suggestions. They strongly approved the idea of uniformity, as did every one who spoke. Attention was called to the fact that the requirement of the specifications, that all specials must be cast in loam, was opposed to present practice, and the committee agreed that this clause should be changed.

Mr. Edwards, of the Montreal Pipe & Foundry Co., thought that the percentage of cut pipe allowed was too small; 10% would be better. He also thought it would be a hardship to the manufacturer to cast class numbers on the pipe, and that they ought not to be required cast with bell up. The hydraulic test he thought too high for small pipe. Mr. Dexter Brackett, of the committee, stated that they had intended to specify that no pipes under 20 ins. should be cut and banded, and he thought 6% a sufficient allowance in the large sizes. Mr. J. A. Gould, Engineer of the Brookline Gas Light Co., stated that they were using the same weight of pipe that the Boston water-works uses for its high service, although they have an internal pressure of only 2 oz. per sq. in., and yet they have broken pipe. Mr. F. L. Fuller said that in his practice he had more trouble from cracked spigots than cracked bells. He also referred to trouble from a fin on the bead of one pipe injuring the coating of an adjoining pipe. A number of other members spoke, and it was evident that the discussion should not be closed, although it became necessary to adjourn on account of the lateness of the hour. A motion was adopted that the discussion be continued at the next meeting, and that the committee be instructed to confer further with the manufacturers. It is probable that the final report of the committee and action by the association will be deferred for several months, in order to take full advantage of the discussions and suggestions from founders.

THE NEEDLESS CHANGES IN THE JEROME PARK RESERVOIR CONSTRUCTION.

By Alfred Craven, M. Am. Soc. C. E.*

Changes from the original plans for constructing certain portions of the Jerome Park Reservoir having been advocated, the Aqueduct Commissioners appointed a Board of Engineers to report on advisability of such changes.

Referring to the text of the report (Engineering News, Nov. 28), it appears:

> The question at issue is whether it is essential to the stability of the embankment and the security of the reservoir against dangerous leaks that these walls should be in all cases founded on the underlying rock.

In answer to this, after reviewing the conditions found, the Board, referring to these core walls, says:

> No material settlement has thus far been observed in these walls, and we consider it not within the range of possibility that the foundations will yield under the completed embankments, or that any material amount of water will find its way through or under them, if they are built in compliance with the specifications.

That another issue was under consideration is evidenced by the following:

> To preclude all possibility of the sliding or slipping of the inner bank . . . etc., we are of the opinion that

*53 Highland Ave., Yonkers, N. Y. (Mr. Craven was for many years a Division Engineer under the Croton Aqueduct Commission. In that capacity he was intimately connected with the Jerome Park Reservoir from 1895 to 1900—Ed.)

the inner slope of the reservoir bank should be made 2½ horizontal to 1 vertical, and that at the intersection of this slope with the reservoir bottom the interior lining of concrete should be made double the thickness that is provided for by the present plans.

I will add here that the form of shoulder or joint at the bottom of the bank paving was left as a detail that had been considered but not fully determined when the general drawings were made.

It appears, finally, in the summary of the report that there is no danger from seepage, and "a large expenditure to absolutely prevent such seepage would not be warranted or advisable."

The question of changes in the construction of this work has been the subject of numerous notices in the press since July, 1901, when it was announced that serious defects had been found

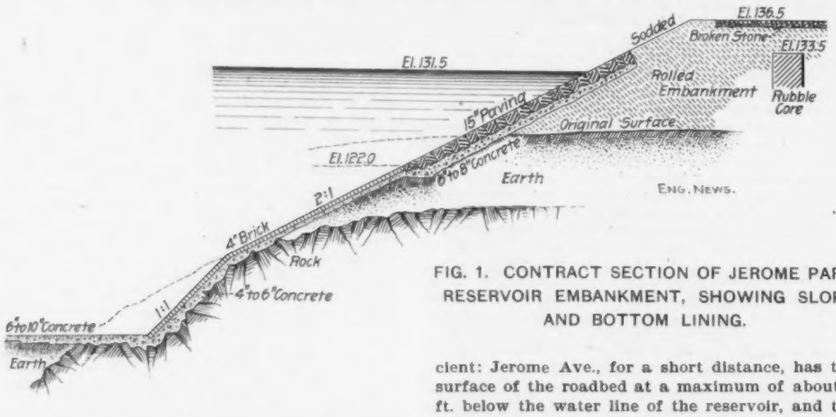

FIG. 1. CONTRACT SECTION OF JEROME PARK RESERVOIR EMBANKMENT, SHOWING SLOPE AND BOTTOM LINING.

in the core wall, cracks had been discovered and the walls were founded on quicksands. The conclusions were that water would find its way through and under the core wall, the foundations would yield, a failure of the core wall and embankment would follow, with consequent disastrous results due to the great flood that would be caused by such failure.

In justice to the engineer who designed this work, and to those who had direction and charge of its execution, it is proper to say that all the above facts as to cracks and the conditions of the foundations were well known and were all entered in detail on the daily records of the progress of the work, not as a matter of serious moment, but merely to keep a full record of the daily observations of even the minutest details.

The changes as originally recommended were based on these two alleged defects, "Cracks in core wall" and "Foundation of quicksand," and incidentally the instability of an inner embankment, due also to the natural conditions of the material on which this bank would rest. With three or four exceptions the cracks in the core wall were due to its long exposure (three years) to violent changes of temperature.

Slight settlement took place where changes of the base of the wall were made from rock to earth, causing ruptures that were insignificant as to their extent.

The cracking of such long walls is always to be expected, and the long retaining wall now constructed on the line of Sedgwick Ave. will meet a like fate, though it has a large section and is founded entirely on rock. As in all similar cases the remedy is simple and inexpensive. It is to calk or plaster over the cracks just in advance of building the banks. Settlement will have ceased, and temperature will no longer affect the walls.

Sand, when confined, as in the present instance, makes one of the best foundations for stability. Such sand as these walls are in is also nearly impervious to filtration, and so far as the passage of water under the wall is concerned, this fine material, indestructible in character, has the facility of adjusting itself to the irregularities of the stone and mortar and effectually closing all defective joints about and under the base of the wall. Added to these excellent conditions, of foundation and imperviability to filtration or seepage, are the favorable topographical features of the surrounding territory.

Furthermore, the contract plans (Fig. 1) provide that the entire bottom of the reservoir is to be covered with from 3 to 10 ins. of concrete, 3 ins. where rock occurs and from 6 to 10 ins. on earth; the water slope of the embankment is to be protected, to a vertical height above reservoir bottom of 12 ft., with 4 ins. of brickwork laid on from 4 to 6 ins. of concrete, and above Elev. 122 these slopes are to be paved with 15 ins. of stone laid on from 6 to 8 ins. of concrete; all of this masonry to be laid with Portland cement.

On the east side of the reservoir (Figs. 2 and 3), Section B-B fairly indicates the most unfavorable conditions north of Kings Bridge Road, where the core wall is now built; a glance at this is sufficient: Jerome Ave., for a short distance, has the surface of the roadbed at a maximum of about 8 ft. below the water line of the reservoir, and the ground continues to rise to the east to a high elevation.

A point that has also been overlooked is that for nearly the whole length of this east wall, and outside of it, an intercepting pipe drain, laid in loose material (broken stone) has been laid to and along Kings Bridge Road with a view at the proper time of connecting it with the sewers at and to the south of the work. The elevation of this drain I cannot now recall, but it is about as represented on Section B-B, Fig. 3.

At the south end of the reservoir, Section A-A, Fig. 3, the valley has been filled, as shown, and the surface slope falls away slowly to the south, only reaching reservoir bottom grade at about 1,900 ft. from the core wall.

The actual conditions of the dam, described briefly, are: An earthen dam with a central core wall, having back of it 23½ ft. depth of water, with a well-protected water slope of 2 horizontal to 1 vertical, and an exterior slope of about 100 ft. to 1.3 ft.

Following from Gate-House No. 6 towards Sedgwick Ave. (see plan, Fig. 2), Section D-D, Fig. 3, will give a fair indication of the topographical conditions beyond the reservoir bank. It illustrates, also, a typical construction (as provided in the plans), and at the same time, by hatched lines, the conditions that will exist under the newly-proposed construction of abandoning the inner embankment, and substituting a face, or retaining, wall.

Along Sedgwick Ave., Section C-C, Fig. 3, is typical of the contract plans. This cross-section, however, has been changed, and the changes are fairly represented by Fig. 4, which shows very approximately, the new retaining wall as now built.

Fig. 5 represents the face wall construction, and Section E-E, Fig. 3, the high dam at the north end of the reservoir, adjoining and to the east of Gate-House No. 2. The maximum height of bank construction, as shown on E-E, extends only for a short distance, as the ground rises rapidly to the east.

For the entire length of this bank, from Gate-House No. 2 to the Old Croton Aqueduct, the core wall was carried to rock. The advisability of such construction at this point is evident from the fact that the natural surface of the ground and the underlying rock fall away rapidly from the reservoir to the north, to tide-water in Van Cortlandt Valley.

This bank, or the highest portion of it, contiguous to the gate-house, was recently built by simply dumping the material from cars from the high level of the top of the core wall. The material was just as it came from the steam shovel. It was not placed in layers and rolled, as a well-made bank should be treated, and as the specifications of the contract provide, nor were the large stones removed. It is true that an extensive fill was contemplated over this outer bank, but this is no justification for neglecting the embankment proper.

Coming now directly to the changes in plans, already made and being made, reference should be had to Figs. 4 and 5, and Section D-D, Fig. 3; the other sections are all typical of the original contract drawings.

In excavating the rock to the west of Gate-House No. 2 it was found to be of a very seamy character, many of the seams being apparently open, standing nearly vertical, and leading directly away from the reservoir. In a tunnel built for the proposed Sedgwick Ave. intercepting sewer these same conditions were noticed (this tunnel was built outside of and parallel with the bank line extending from the outside of Gate-House No. 2 to Sedgwick Ave.). It was therefore necessary to take some precautions to prevent water that might find its way through the reservoir lining from following the seamy formation to the north, where, as before stated, the adjacent territory falls away rapidly from the reservoir.

Instead of building a core wall directly in the rock, as indicated in Fig. 4, it was concluded to build a face wall, as shown, of practically the same section as the core wall. This was so or-

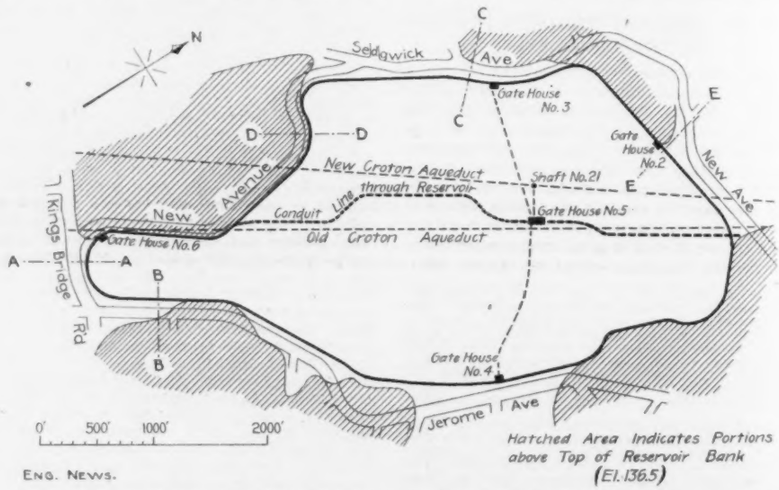

FIG. 2. GENERAL PLAN OF JEROME PARK RESERVOIR.

dered in the winter of 1899. It was not definitely decided, however, even with this construction, to abandon the inner bank and paved slopes, but this question was left for future consideration.

This face wall was to extend to the west a few hundred feet, or until the character of the rock

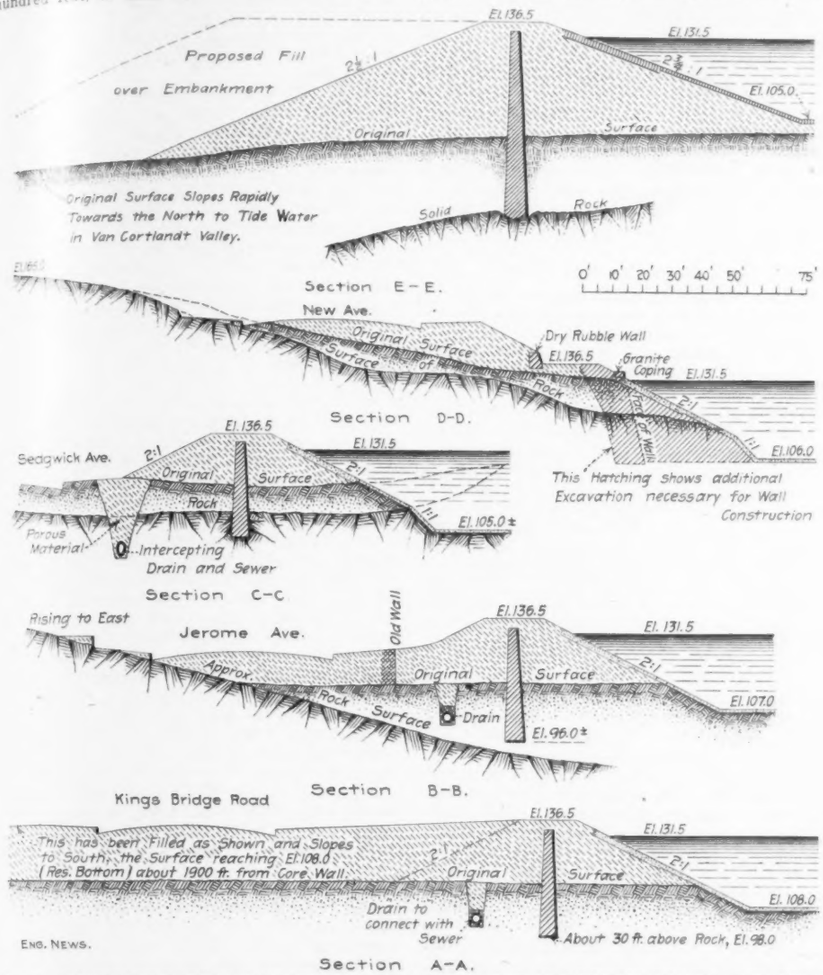

FIG. 3. CONTRACT SECTIONS OF JEROME PARK RESERVOIR AT VARIOUS POINTS (SEE FIG. 2).

improved, when it was to have been merged gradually or changed abruptly to the ordinary embankment construction. Instead of this, however, at a later date the retaining wall construction (Fig. 5) was ordered on the ground of developments of quicksand that, it was alleged, would make the banks unstable; the same reason advanced for the changes recommended at the south and east sides of the reservoir; changes not approved by the Board of Engineers.

This construction was continued for 2,500 ft. or more, and preparations are now being made to extend it, or a somewhat similar construction, to the eastward. Section D-D, Fig. 3, shows the uselessness of such construction, as the entire territory included by the reservoir on the north and east, Sedgwick Ave. on the west, and Kings Bridge Road on the south, rises far above the water level of the reservoir and forms an impassible barrier to water.

The difference in cost due to these changes will be, along Sedgwick Ave., about double that of the original plans; and there will probably be a larger difference to the east from Sedgwick Ave., as here no core wall was required and considerable already completed bank is being torn out.

Evidences point to the abandonment of the intercepting drain and sewer shown on Section C-C, Fig. 3. This sewer was considered of great importance to drain the outer bank, should water reach it, and to protect the city from claims for damages. For as certain as moisture appears in a cellar to the west of Sedgwick Ave., so certain will it be attributed to leakage from Jerome Park Reservoir. This sewer was a precaution well considered, and should not have been abandoned.

I desire to particularly mention, at this point, that the Board of Engineers were not called upon to report on any conditions beyond the long line of core wall on the east and south sides of the reservoir, which, therefore, must admittedly have been considered the point of greatest danger.

It is then evident that their report, stating so clearly as it does that a change in construction would be ill-advised at the south and east sides, on the ground that the expenditure of money would be unwarranted, must practically condemn the changes already made where the core wall

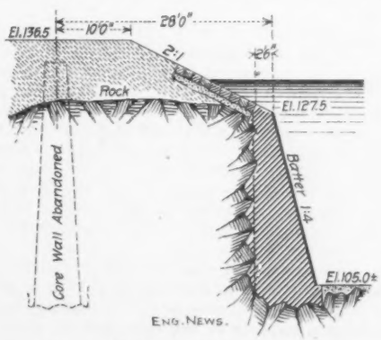

Fig. 4. Retaining Wall Construction.

was to have been carried to rock and where there is no "quicksand" to contend with nor are there valleys to be washed out.

There is absolutely no necessity for these changes. They are clearly no improvement on the original plans; they are in point of fact more costly, and will in no way give better or even as good results as the embankment construction with the well-built core wall. The large retaining wall will not be impervious to filtration, and it will lack the protecting influence of a well-made inner bank.

Other changes have been made. The great central gate-house, which, as well as the rest of the work, was designed by an eminent engineer, has been remodeled at a large additional (about double) cost. Its efficiency has not in any way been improved. In fact, the most important feature in the original design, making each of its functions entirely separate from all others, has been practically obliterated.

The necessity for the changes, it may well be said, have been fairly proved not to exist. Why, then, were they made?

It seems further discussion is unnecessary. There is one point, however, that has appeared as a reason to offset an acknowledged increase in cost of construction. That is, by obliterating the inner embankment of the reservoir, additional storage capacity has been added that will more than offset this difference in cost of construction.

The additional storage capacity is a mere drop in the bucket. Eighteen hundred million gallons is the established capacity of this reservoir. The increase, due to the changes in construction already made, is about 10 to 12 million gallons; that is, under the assumption that the reservoir will at some time be drained to its bottom. This is expensive storage, especially when it is considered that there are portions of the reservoir where by a slight change in the line of construction additional storage equivalent to that to be obtained by changing the methods of construction may be had at a cost that is trivial as compared with the proposed and partially-executed methods. The small addition to the original proposed capacity of this great reservoir, however, as compared with the amount of water consumed daily, is inconsequential.

There is absolutely no reason or justification for the changes made and contemplated. This great reservoir is in the midst of what is destined to become a densely-populated district. More than ordinary precautions were considered in its design; every safeguard was provided, and the general contract plans were more than usually complete, owing to the fact that the several items were large, and it was proper that those who bid on the work should have all the information possible to guide them.

The specifications amply provided for detailed plans to cover just such points as the one recommended by the Board of Engineers to increase the thickness of the masonry, forming a shoulder or abutment at the junction of the bank paving with the lining of the reservoir bottom.

This matter had already received due consideration. Also possible changes in lines and grades were considered in the specifications.

On the other hand, changes of such magnitude as have been made, and are sought to be further extended, may seriously affect the entire con-

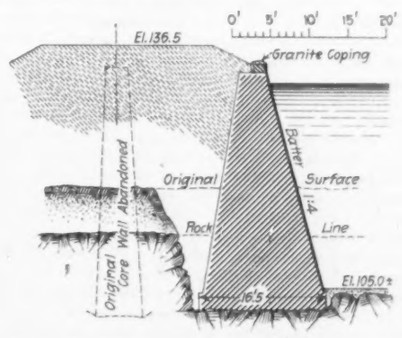

Fig. 5. Face Wall Construction.

tract; but they will injure the city, only, for the contractor, very properly, may not be made to suffer when called upon to build on lines so radically differing from those on which he made his bid for the work, and that incidentally cause serious delays in its completion.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

The successful transmission of signals across the Atlantic Ocean by wireless telegraphy, which was accomplished by the Italian inventor, Guglielmo Marconi, on Wednesday, Dec. 11, is entitled to rank among the notable achievements of the present century. The success of wireless telegraphy over moderate distances has justified the hope that much greater spaces would eventually be spanned by it, but the sudden leap from transmission over a hundred miles or so to the 1,800 miles distance from Newfoundland to Cornwall, was a surprise to even the most sanguine.

According to the press dispatches, Signor Marconi established his Newfoundland station primarily to send signals to Transatlantic steamers, although he also hoped to achieve success in sending signals across the ocean. He arranged with the operator at his station located at Poldhu, Cornwall, to send certain signals when his apparatus at St. Johns, Newfoundland, was ready. On Monday, Dec. 9, he cabled the operator to send signals from 3 to 6 p. m., daily, the signal to consist of the letter S in the Morse code, repeated at intervals. On Wednesday a vertical wire was elevated by a kite, and the signals were faintly perceived. On the following day the test was repeated, and announcement of the success was then made. The St. John's station is not yet equipped with sending apparatus, so that transmission was possible in only one direction. It is stated, however, that, encouraged by the success thus far attained, a large and completely-equipped station will be erected on the Newfoundland coast, and will be used both for signaling to ocean steamships and for transoceanic transmission.

Whether the new system of transmission is likely to supersede the submarine cable is a question that no one is yet wise enough to answer. That wireless telegraphy can be made a commercial success over moderate distances is now well established; but it does not follow necessarily that over such great distances as that from Europe to America the system can be made so reliable, free from interruption and from unauthorized interference that there will be no business left for the cable companies. In fact, the competition of the new method may prove just the stimulus needed by the cable companies to improve their methods, increase their speed of communication and reduce their rates so as to make their lines more generally available.

Meanwhile the new system promises to have a field of great usefulness all its own in communicating to or between moving vessels, and thus removing, or at least mitigating, some of the danger which now attends the movement of ships at sea in time of fog or storm.

We take pleasure in again calling attention to the convenient blank form for a summary of water works statistics printed by the New England Water-Works Association. The form is printed on one side of the paper only, so when filled in it can be sent directly to the printer with the other manuscript for the annual report. The circulation of this form a year ago appeared to double the number of works that made use of the uniform schedule recommended by the association. The use of that schedule is by no means limited to members of the association, nor is there any reason why it should not be used by private water companies. The figures thus made available and comparable are published in tabular form in the "Journal of the New England Water-Works Association." Copies of the blank may be obtained from Mr. Chas. W. Sherman, Editor of the "Journal," 1 Ashburton Place, Boston, Mass.

The arbitration over the question whether direct-current or alternating-current motors should be used in equipping the London underground railways for electric traction has resulted in a verdict in favor of direct current. The controversy over this matter has been a long and animated one, and a large number of American, English and Continental experts were brought forward to give testimony by the opposing sides.

As many of our readers will remember, the London underground system is owned and operated by two different companies, known as the District Ry. and the Metropolitan Ry. A part of the system is used jointly by the trains of the two companies, and Parliament, in granting authority to the companies to adopt electric traction on their lines stipulated that the two companies must agree upon the same system. Bids for the equipment of the two systems were invited and received in 1900, and among them was one from Ganz & Co., of Buda Pesth, for a three-phase alternating current system. The acceptance of this bid was recommended by a joint committee made up from the directors of the two companies, on the advice of Sir Wm. Preece and other noted electrical engineers.

Meanwhile, Mr. R. W. Perks, Chairman of the District Ry. Co., induced Mr. Chas T. Yerkes, of Chicago, to purchase a large interest in the District Co., and on the advice of Mr. Yerkes and engineers familiar with American practice in electric railway work, Mr. Perks decided that his company should favor direct current for its equipment. The Metropolitan Co., however, had decided on the Ganz system, and a deadlock between the two companies resulted until the Board of Trade stepped in and ordered an arbitration to settle the matter.

In both systems it was proposed to distribute alternating current at high potential from a central power station to substations on various parts of the system, but in the plan favored by Mr. Yerkes, rotary converters were to be placed in these substations and direct current was to be taken from them and delivered to a third rail at 550 volts. In the Ganz system, the substations contained only stationary step-down transformers, and these were to deliver a 3,000-volt alternating current to three parallel overhead trolley wires, from which it was to be collected by sliding shoes supported from the roof of the car.

The points urged in favor of the [illegible] system were that its first cost would be about $700,000 less than the direct-current system, and that the loss in the rotary converters and in the third rail distribution would make the total loss in the direct-current distribution 13 to 15% greater than in its rival. It was also claimed that the alternating system had an advantage in the use of the motors as generators to return current to the line in stopping.

On behalf of the direct-current system it was urged that that system was thoroughly established and standardized by long experience, whereas the alternating system as proposed by Messrs. Ganz was in many details entirely experimental, and the danger to life and the risk of interrupted service were very great. As may be imagined from the verdict, the direct current advocates were able to make considerably the stronger showing.

The announcement of the verdict was immediately followed by a large rise in the prices of the railway companies' shares on the London stock exchange, and by the closing of a contract with the British Westinghouse Co., for the power station equipment.

By an act of Congress approved Feb. 2, 1901, "To increase the efficiency of the permanent military establishment of the United States," the Corps of Engineers of the United States Army was increased in numbers to 160 officers. But, in an unthinking moment, the framers of the bill limited this increase to the junior officers of the corps. The practical result of this act was to destroy the then existing ratio of field officers to subalterns; a ratio which had previously assured a slow but reasonable rate of promotion among the junior officers and made it an incentive to the graduates of the Military Academy to enter the Engineer Corps, whenever so recommended. The effect of this decreased chance for promotion is already noted in the fact that comparatively few officers of the army are applying for transfer to the Engineer Corps, under the provisions of the present law; and it will be difficult to attract the honor graduates of the Academy to the corps in the future. To remedy this unintended injustice to the corps, Brig.-Gen. Gillespie, Chief of Engineers, U. S. A., in his last annual report, urgently recommends such increase in the number of field officers in the corps as will re-establish the ratio prevailing before the passage of the act.

This recommendation is not only just, but is also wise; and in line with the best interests of the army and the government. For many years past the highest prize held out to the graduates of the Military Academy was admission to the Corps of Engineers. To enter the corps at all the graduates had to head their class; and the best trained men only formed that corps. The effect of this system is seen in the high class of technical work, theoretical and practical, performed by the members of this corps, and in their general high standing in the army. It was a recognized honor to be connected with such a body of men, and the brightest and ablest students at the Academy strove for admission to their ranks. Under the old law promotion was slow enough; but a law which will compel a man to serve as a Lieutenant all the best years of his life is most unwise, and can only have one of two results. Either the best graduates of the Military Academy will seek other branches of the military service, where promotion is more rapid; or, they will leave the military service entirely after a few years, and find better-paid employment in the civil branches of the profession of engineering. The logical outcome of either one of these propositions is the greatly impaired efficiency of the Engineer Corps of the United States Army. Instead of being made up, as now, of the best men leaving the Academy, it will in time include only those who have neither the ambition nor the ability that would lead them to success in other walks in life; and are simply content to occupy a poorly paid government position that holds out little or no hope for promotion.

Remembering the great sums of money which are expended on government works under direction of the Corps of Engineers, the importance of maintaining the standard of that body is evident, and Congress will do well to adopt Gen. Gillespie's recommendations.

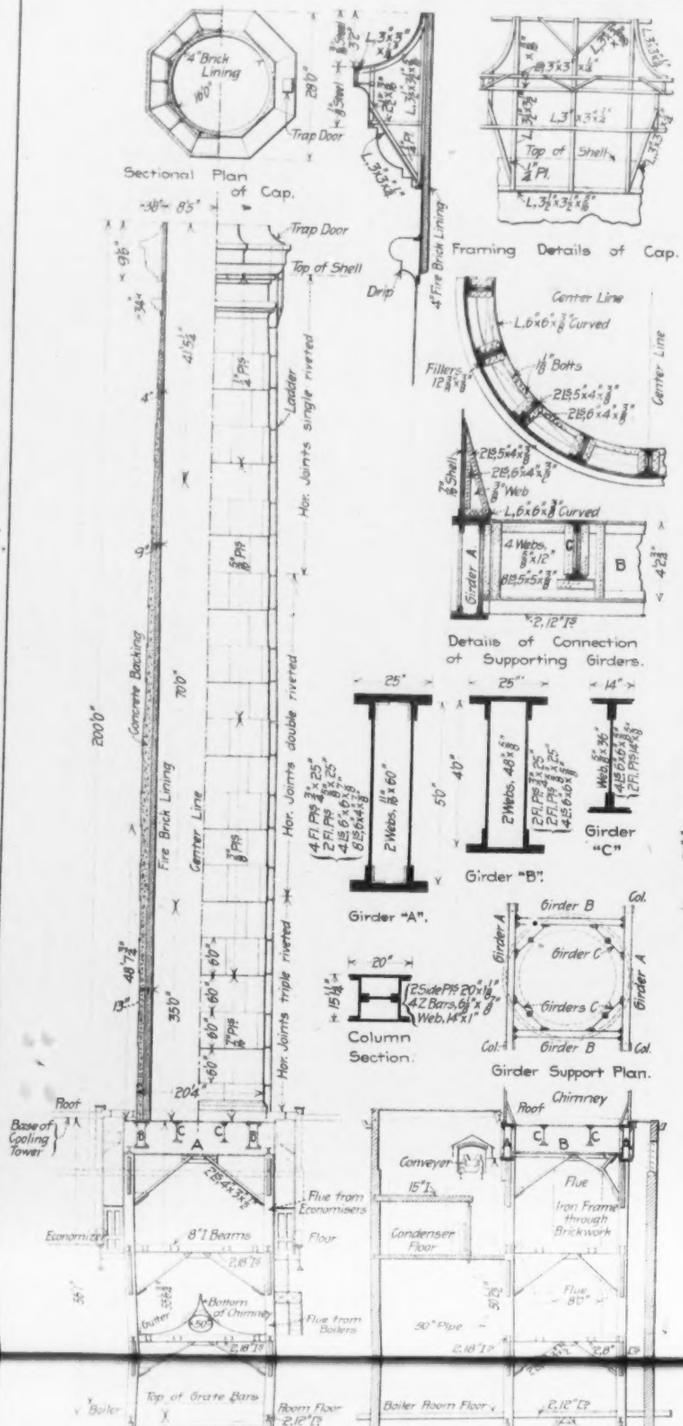


FIG. 4.

STEEL CHIMNEY FOR CINCINNATI GAS AND ELECTRIC CO.

E. O. Elzner, Designer.

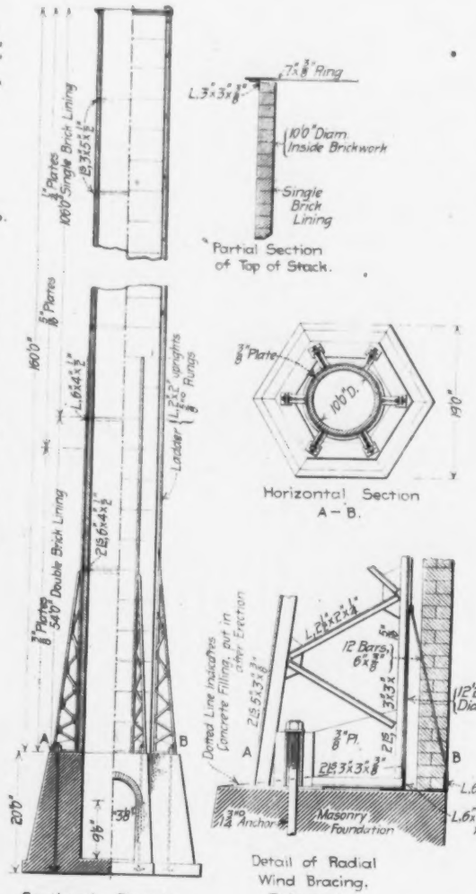


FIG. 5. STEEL CHIMNEY FOR OSCEOLA CONSOLIDATED COPPER CO.

J. F. Jackson, Assoc. M. Am., Soc. C. E., Designer.

Milwaukee Bridge & Iron Co., Builders.

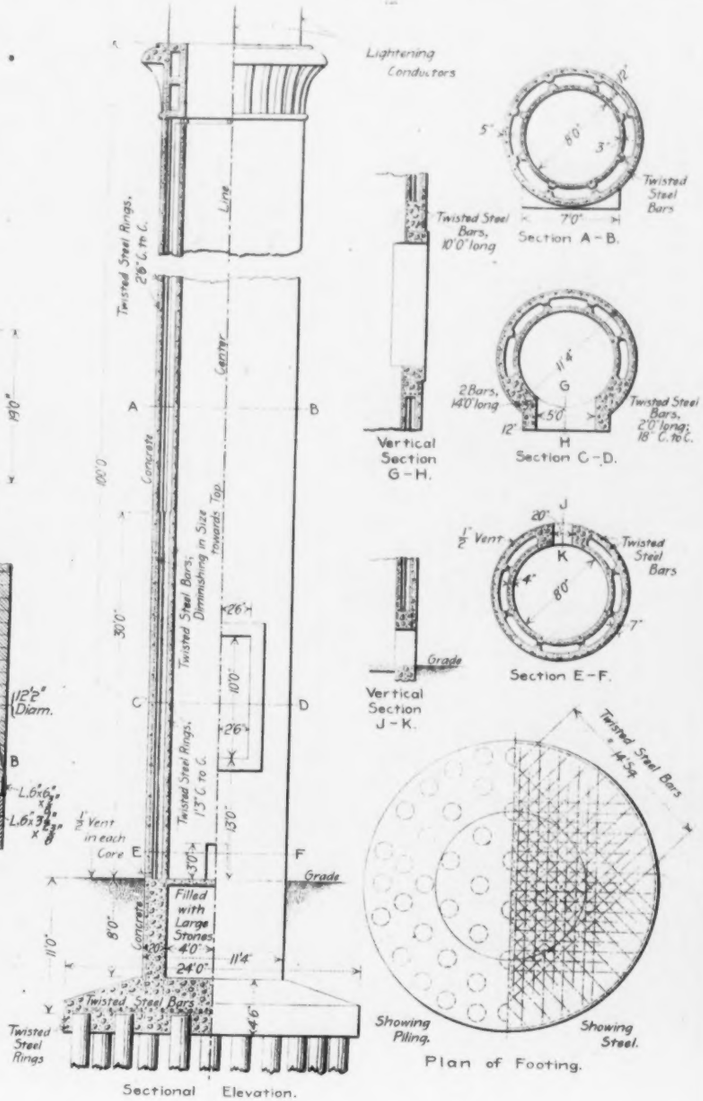


FIG. 7. STEEL CONCRETE CHIMNEY FOR CENTRAL LARD CO., JERSEY CITY.

Ransome Concrete Co., Designers.

Morris Building Co., Builders.

DETAILS OF

STEEL CHIMNEY
FOR CINCINNATI
GAS AND
ELECTRIC CO.

E. O. Elzner,
Designer.

L. Schreiber & Sons Co.,
Builders.

DETAILS OF

RECENT TALL CHIMNEYS.

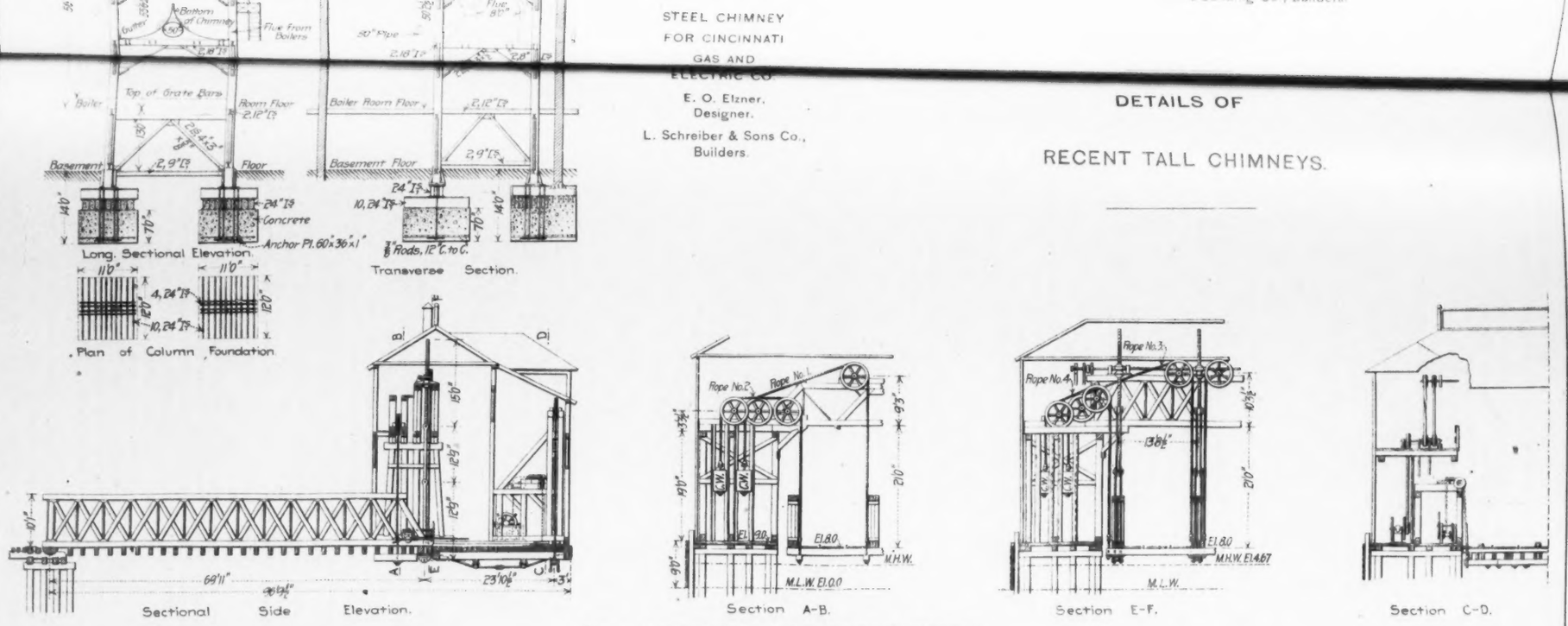
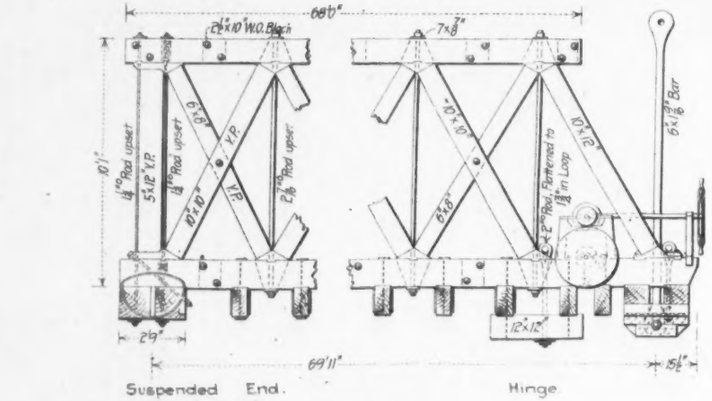
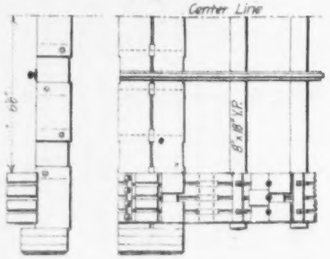


FIG. 1. LONGITUDINAL AND TRANSVERSE SECTIONS.





FIGS. 2-3.
DETAILS OF
HINGE AND
SUSPENDED
END
OF BRIDGE.

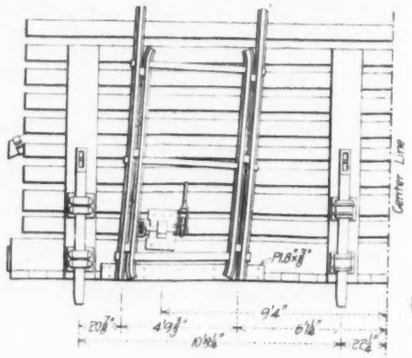


FIG. 5.
PART PLAN
OF
APRON.

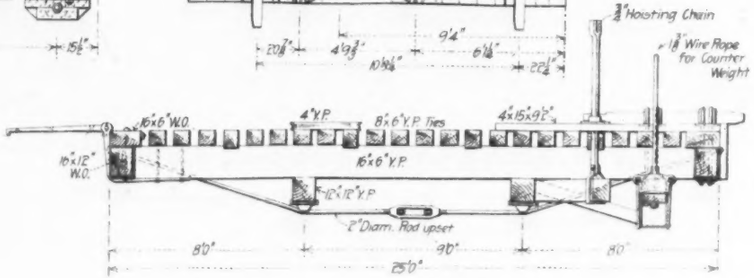


FIG. 4. SIDE ELEVATION OF APRON.

STANDARD

CAR-FERRY TRANSFER

BRIDGE,

NEW YORK CENTRAL &

HUDSON RIVER R. R.

W. J. Wilgus,

M. Am. Soc. C. E.,

Chief Engineer.

CHAS. HART, LITH., 86 VESSEY ST., N. Y.

THE PENNSYLVANIA AND LONG ISLAND R. R. EXTENSIONS ACROSS THE NORTH AND EAST RIVERS.

The most important engineering enterprise put under way in a long time was formally announced last week by officials of the Pennsylvania R. R., and its controlled system, the Long Island R. R., the object of which is to obtain a passenger terminus for these two railways in the heart of New York city.

Briefly stated, the Pennsylvania is to cross the North River by two parallel single-track tunnels and run its trains into an underground station located at 7th Ave. and 33d St., in New York city. The trains will continue on from this station through two tunnels running underneath the East River to terminal yards on Long Island. There will also be two other tunnels under the East River from the station above referred to, for the use of Long Island suburban trains.

For many years the desire of the Pennsylvania R. R. officials to obtain a terminus for their road on Manhattan Island has been well known, but the broad North River is a barrier which neither the builder of tunnels nor the builder of bridges has yet been able to pass. The river is ⅝ to ⅞ of a mile in width. It carries a traffic which demands a height of 150 ft. or more for any bridge planned to cross it, and such a height would require, of course, long and expensive approaches, crossing very valuable real estate on either side. The projector of tunnels, on the other hand, finds a depth of water in the river of 50 to 70 ft., under which is a very deep deposit of soft silt, extending down to the bedrock.

A dozen years or more ago it was proposed to carry a tunnel under the North River, from a point near the Pennsylvania's present Jersey City passenger terminal, so as to land passengers in an underground station at Cortlandt St. and Broadway, near the lower end of Manhattan Island. Thence the tunnel was to continue on under the East River, so that Brooklyn passengers would be landed in a station in their own city and would avoid the present transfer by the "Annex" ferryboat.

There were very good reasons, however, why this project was never carried out. For one thing, the unfortunate Hudson River tunnel about that time demonstrated what large uncertainties and grave perils attended the work of tunneling through the silt which underlies the North River. For another, it was realized that the operation of any such tunnel with steam locomotives would involve great difficulties.

About that time, too, attention was diverted to projects for bridging the river instead of tunneling. Two rival bridge projects struggled for favor, one of which proposed to cross by a single span; the other proposed to place a pier in the center of the river. The Pennsylvania R. R., it is said, was interested in the latter project; but the decision of the Board of Engineers was against the obstruction of the river by a pier. Next came the hard times of 1894, and bridge and tunnel enterprises alike were laid on the shelf.

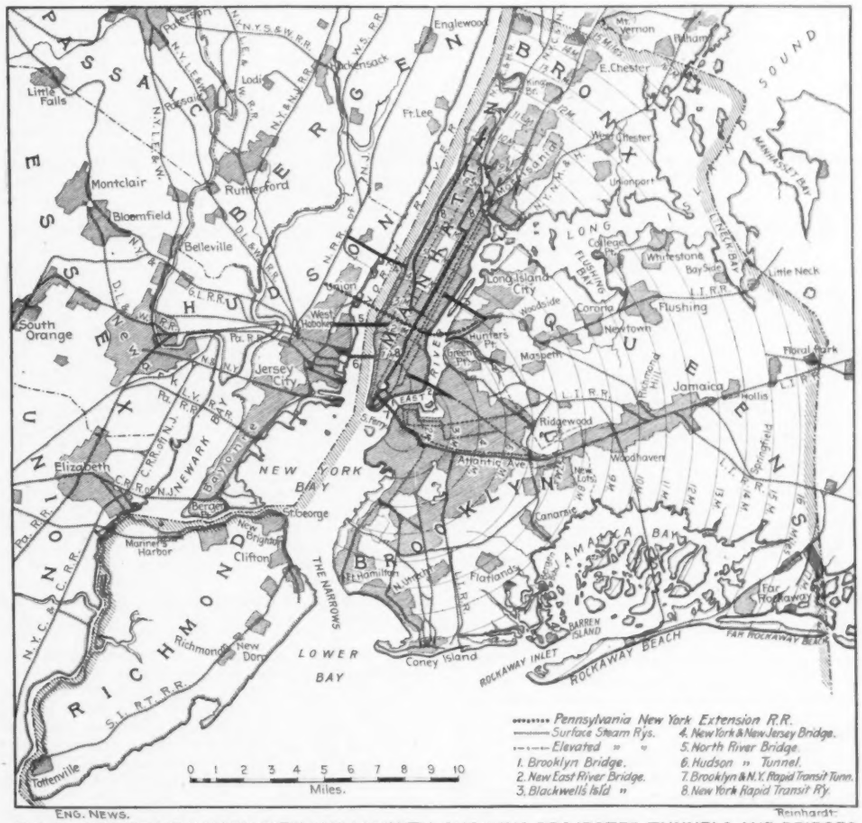
With the return of prosperity, the bridge project was again taken up, and at one time the prospect seemed exceedingly favorable that the great North River bridge planned by Mr. Gustav Lindenthal, M. Am. Soc. C. E., would be financed by all the railway companies whose lines enter Jersey City. The Pennsylvania officials were, it is reported, desirous of undertaking the work on such a basis; but the negotiations have never reached a successful conclusion.

Turning now to the opposite side of the river, it is well known that the Long Island R. R. has long been desirous of running its trains onto Manhattan Island. The late Austin Corbin at one time was deeply interested in a proposed deep-tunnel line to connect the Long Island and Philadelphia & Reading systems, landing passengers in New York at a station near the Battery, at the lower end of Manhattan Island. Later it was proposed to cross the river by a great bridge at Blackwell's Island, and following this projects have been at various times put forward for tunnels under the East River.

About two years ago control of the Long Island system was secured by the Pennsylvania, and it now appears probable that one main purpose of the Pennsylvania officers was to unite the two companies in the work of creating a terminal station on Manhattan Island. If trains were to be brought across the North River, it was practically necessary that they should continue on under the East River to a terminus on Long Island. It would be financially impracticable to build on the crowded area of Manhattan Island, where real estate valuations are so enormous, any such great station and yards as would be required to handle the Pennsylvania passenger trains at a dead end terminus such as that at Jersey City, for example. As for the proposition to build such yards underground, we need hardly say that this was even more impracticable, both from the financial and the operating standpoint. With the two roads under one control, however, they are able to serve each other's purposes admirably.

The work of greatest interest to engineers in connection with this enterprise is the tunnels underneath the North River. Experience on the old Hudson River tunnel has demonstrated that the silt in the bed of the North River is about the most treacherous material through which submarine tunneling has ever been attempted. The only way in which a tunnel can be driven through it is by the use of a hydraulic shield and cast-iron lining, together with the use of compressed air; and the silt is so yielding and semi-fluid in consistency that it is quite doubtful whether an ordinary cast-iron-lined tunnel would not be distorted and fractured by the movement of trains.

To meet this difficulty, Mr. Chas. M. Jacobs, the engineer in charge of this work for the associated companies, proposes to stiffen the tunnel by a pair of trusses placed in its interior and to support the



ENG. NEWS. Reinhardt.

FIG. 1. MAP OF NEW YORK CITY AND VICINITY, SHOWING PROJECTED TUNNELS AND BRIDGES ACROSS THE NORTH AND EAST RIVERS.

(Reproduced, with some additions, from Engineering News of Nov. 25, 1897. The map was published in connection with an editorial summary of the existing and proposed transit lines across the East and North Rivers. Several of the projects which were then active have since been abandoned. The line No. 7 across the East River, represents the tunnel which was then projected by the Long Island R. R. Co. This has been abandoned and in its stead a little farther south is the location along which the New York Rapid Transit Commission has recently made borings for a Brooklyn extension of its lines. No. 3 represents the Long Island R. R. Co.'s proposed Blackwell's Island bridge. This has also been given up and at a site near by the city is now at work on what is officially known as "East River Bridge No. 3." The site of "East River Bridge No. 4," whose construction has been decided upon by the city since the map was published, is between the bridges numbered (1) and (2) on the map.)

The accompanying map and profile, compiled from those filed by the railway officers in the County Clerk's office, will make clear the general route of the proposed tunnel lines. As there seen, the station is to be located on the block between 7th and 8th Avenues and 32d and 33d Sts., and a considerable part of the real estate necessary has already been acquired. The area required for the station and yards will be cleared and excavated in open cut. The tracks and platforms will be located about 25 ft. below the street level, and above them will rise a great station, office building and hotel. The excavation for this area, as well as the tunnels for nearly their whole length on Manhattan Island, will be in solid rock.

From the station westward the tracks will converge into parallel single-track tunnels which will be carried across the North River through the silt stratum and thence through the rock ridge of the Palisades till they reach a portal at the level of the Hackensack meadows in West Hoboken. From this point the tracks will run westward to a connection with the present main line of the Pennsylvania somewhere near Newark.

ends of these trusses on piers carried down to bed rock. Application for a patent has been filed by Mr. Jacobs on this novel and unprecedented system of tunnel construction, and at a later date we hope to describe and illustrate it in detail. At present it may be said that the tunnel will be driven with a shield in the usual manner, and then traps will be opened in the bottom at suitable intervals, say 150 ft. or more, and cylinder piers will be carried down to bedrock. Later interior trusses will be erected with their ends resting on these piers and firmly secured to the sides of the tunnel. In the completed structure, therefore, the weight and jar of trains will not be carried by the tunnel lining and transmitted to the earth in which it lies as is usually the case. Instead, the trusses will carry the weight of the train and transmit it to the piers.

We need hardly say that the driving of tunnels of the diameter proposed (18 ft. 6 ins.), and the sinking of the supporting piers to bedrock at a depth exceeding probably the greatest at which compressed air has ever been used, is likely to be an exceedingly difficult piece of engineering work.

The fact that it has been formally adopted by the Pennsylvania officials, however, is good evidence that the difficulties have been carefully weighed and found to present no insurmountable barrier to the success of the work.

Besides the two tunnels under the North River, there will, as stated above, be four tunnels under the East River, where the difficulties are only a little less than those to be met under the larger stream. Altogether there will be probably not less than seven miles of soft ground tunneling, and an estimate of $2,000,000 per mile for this work would probably not be excessive. The tunnels across Manhattan Island and through the rock of the Palisades will be comparatively simple and cheap construction, and should offer few difficulties.

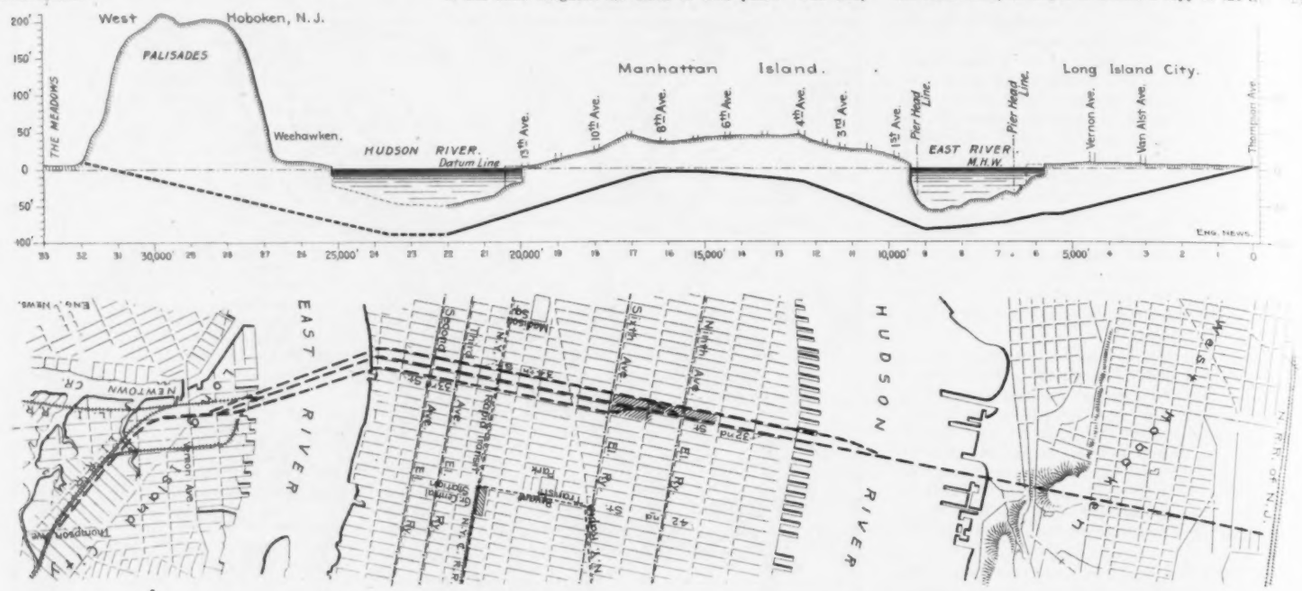


FIG. 2. MAP AND PROFILE OF PENNSYLVANIA-NEW YORK EXTENSION R. R.

(Compiled from Official Map filed in County Clerk's Office and from Topographical Maps of New Jersey.)

Turning now to the plans for operation of these new lines, it need hardly be said that electric traction alone will be used. Suburban train service on the Long Island at least, and very likely on the Pennsylvania as well, will probably be operated entirely by electricity, and if the multiple-unit system is adopted, no switching or reversing of motors will be necessary in the 33d St. station. Through trains on each road will have the steam locomotive detached and an electric locomotive substituted before passing into the tunnel.

It must not be supposed that the creation of the new terminal will mean the abandonment by the Pennsylvania of its present great Jersey City station, or by the Long Island of its various terminal stations in Brooklyn. The traffic capacity of the tunnel lines will be far too small for this, even if it were desired. If we allow an interval of 150 seconds between trains—and less than this would hardly be warranted in passing through a 3-mile tunnel—we have only 24 trains an hour as the maximum that can be sent out of the station.

What the new terminal and its connecting lines will be expected to do for both companies is to draw to them traffic which they do not now receive, and provide for the growth that is all the time going on. Probably three years at least will be required to complete the work, and by that time the additional terminal facilities will doubtless be a welcome relief to the crowding of trains and traffic in the present terminal stations.

LETTERS TO THE EDITOR.

Temperature Stresses in Stiffening Trusses of Suspension Bridges.

Sir: Regarding the communication of Mr. Joseph Mayer in your issue of Dec. 12, on the above subject, I wish to suggest that Mr. Mayer submit his proof to some mathematical analyst of the same high order as Professor Melan for examination of his theory. If it should be endorsed by an accepted authority, Mr. Mayer could then present the matter in a paper to the Am. Soc. C. E. I believe that without such endorsement his theory would hardly be worthy of presentation to that society.

Mr. Mayer has not stated Professor Melan's or my views with accuracy in his communication, which is an additional reason why I do not care to continue the discussion.

Gustav Lindenthal.

45 Cedar St., New York, Dec. 17, 1901.

State Irrigation Canals Under the Carey Act—A Correction.

Sir: Replying to your letter of Dec. 5, I would say that Wyoming was the first state to build a canal under the Carey act. The Big Horn Basin Development Co. has irrigated 29,000 acres under this act. Most of it, I understand, is under cultivation; a considerable portion of it has been irrigated for three or four years. The Cody canal irrigates 25,000 acres; the Cincinnati canal irrigates 18,000 acres; the Yellowstone Park canal irrigates about 7,000 acres; all these were built under the Carey act. The Cody canal company is at work on another canal to irrigate 75,000 acres which has been segregated under this act, and about 30,000 acres has been segregated under this act on Blacks Fork creek in southwestern Wyoming. The canal to irrigate this has been begun, but never completed.

In Idaho there is a canal starting near Blackfoot, on Snake River, which is to irrigate about 60,000 acres under this act. Part of this land is already irrigated, just how much I do not know. Another project under this act contemplates the irrigation of 200,000 acres, the water to be taken out near Shoshone Falls on Snake River. As yet it is only a paper project. This, I think, completes all work done under this act outside of the canal in Montana, mentioned in your issue of Nov. 21.

Sincerely yours, Elwood Mead,
Expert in Charge of Irrigation Investigations.
U. S. Dept. of Agriculture, Office of Experiment Stations,
Washington, D. C., Dec. 6, 1901.

(After the note relating to the Dearborn Canal, in Montana, appeared in our issue of Nov. 21, our attention was called to the fact that this was not, as there stated, the first State canal. We thereupon requested Mr. Mead to give us the facts in the case, as he understands them. This he has very kindly done, as printed above.—Ed.)

The Experts' Report on the New Croton Dam and the Possible Uselessness of Masonry Core-Walls in Earth-Dams.

Sir: I have read with interest the report of the Board of Engineers on changes in design of the New Croton Dam, and the method of constructing the core-walls of the embankments impounding the Jerome Park Reservoir, as printed in your issue of Nov. 28. I was especially interested in the data relating to the penetration of water into embankments, and the slope of the line of saturation, having just finished a high earthen dam for the Standard Electric Co. of California.

While the report, as published, gives the conclusions and results of the investigation, it omits the analyses and tests, and fails to describe the physical condition of the materials of which the dams are made. It appears from their investigation that all the earthen dams in the Croton valley—with possibly one exception, the New Croton Dam—have core-walls that are not impervious. The writer would like to ask, *of what use are they?* This is thoroughly American, but believes the English method of constructing earthen dams, as practiced in India, far better.

The Tabeaud Dam, just finished for the Standard Electric Co., has no core-wall, only a central puddle-trench, being of the homogenous type. The dam is 636 ft. long and 120 ft. high at the center. It has a top width of 30 ft. at the ends and 15 ft. at the center of the crown. Its slopes are 2½ on 1 and 3 on 1.

The writer hopes at some future time to give his professional brethren a minute description of the construction of this dam, with the results of his experiments. In the mean time, he hopes to secure a copy of the Croton report referred to, that intelligent comparison of materials and methods of construction may be made.

Very truly yours, Burr Bassell, Engineer in Charge,
Standard Electric Co. of California.
Electra (via Jackson), Cal., Dec. 7, 1901.

(The appendix to the expert's report, to which our correspondent refers, was not supplied to us. We understood, however, that it consisted of the results of physical tests of material from the various earth dams. These results were summarized in both the experts' reports, and in the memoranda by Mr. Sweet (one of the experts). The character of the earth at the New Croton Dam was also described in Mr. Fteley's letter, in our issue of Dec. 12.—Ed.)

Random Notes of an Engineer.

Sir: I have lately returned from an Eastern trip and perhaps some of the things I learned on my journey may be of interest to engineers.

DENVER.—So severe was the panic of 1893 in Denver that the city did not fairly begin to recover till 1898. Thus its growth in population during the decade from 1890 to 1900 was slower than the census figure would indicate. The absorption of the adjoining districts during this period caused an apparent increase from 107,000 to 134,000, while the real increase was only about 8,000.

Many manufactories have been established in and near the city during the past six or eight years, and the manufactured products, including the output of the smelters, now amount to $50,000,000 per year. The manufacture of mining and smelting machinery has become very extensive, and the supply for much of the country further west and for Mexico is shipped from here. What is not manufactured in this line is carried by the wholesale houses, so that almost anything of the kind needed can be obtained.

Denver has long had a most excellent street railway service. Two extensive systems of cable line roads were built in 1888 and 1889. On one of these the motive power was long since changed to electricity, and about two years ago the other one was changed. The expensive cable machinery was rendered nearly worthless, and what could

not be used for other purposes was consigned to the scrap heap. Of the two costly power houses, one is now used as a storage warehouse, and the other has part of its interior used for a power station for the electric roads.

There are now 152 miles of single-track electric railway, and also some old horse-car lines, all owned by the Denver Tramway Co. Nearly all the track is 3½-ft. gage. The system reaches all parts of the 49 square miles contained within the city limits, and also all of the suburbs. About 75,000,000 passengers are carried yearly. The patronage of the street car lines is much reduced by the number of bicycles in use. It is said that Denver has over 30,000 of these useful machines, more in proportion to its population than any other city in the world.

For the past 12 years all municipal construction work in Denver has been in charge of a Board of Public Works, appointed by the Governor of the state, and during most of this time the care and maintenance of all streets, sewers, bridges, in fact nearly all the municipal improvements, have devolved on the board. The board has its own engineering force, and about all that the city engineer or surveyor has to do is the running out or retracing of street, block and lot lines. All of the paving and much the greater part of the sewer construction have been done since the Board of Public Works was first created. Up to the end of 1900 the following had been the amount and cost of certain public works: Asphalt paved streets, 16.4 miles, costing $1,566,000; sandstone block paved streets, 2.3 miles, cost $263,000; macadam paved streets, 2.1 miles, costing $122,000; paved alleys, 3¼ miles, costing $50,000; total in round numbers, 24 miles, costing $2,000,000. Of sewers, 211.1 miles of sanitary sewers, costing $1,889,000; 39.2 miles of storm sewers, costing $721,000; the combined storm and sanitary sewer on Delganey St., 3.6 miles long and costing $337,000; total in round numbers, 254 miles, costing $2,900,000.

The Denver Union Water-Works Co. furnishes the city with its water supply, the consumption during the summer months amounting to 30,000,000 gallons daily. The water all comes from the mountains, 20 miles distant, partially from underground sources; and is all filtered, either naturally or mechanically. In the city are about 500 miles of mains. For the parts of the city above gravity pressure, pumps are used to lift the water to elevated reservoirs.

The suit instituted against the water company by the city, to settle controversies of several years' standing regarding the purity and the sufficiency of the pressure, resulted favorably to the company.

COLORADO SPRINGS.—This beautiful city has grown very rapidly during the past three years. Though it is essentially a residence place, it has become the headquarters of most of the large mining and railway enterprises of Cripple Creek. Colorado City, adjoining on the west, is becoming quite a center for ore reduction works.

CRIPPLE CREEK MINING DISTRICT.—This world-famous gold camp, only a few miles southwest of Pike's Peak, has continued to develop steadily since my last visit, 3½ years ago. In 1891, when gold was first discovered the value of the production was $2,000,000; in 1897 it was $12,500,000, and in 1900 it was $22,500,000. The value for 1901 will probably be $25,000,000. Its total product up to the end of 1901 will be over $115,000,000.

The average value for all ores up to July 1, 1901, was about $43 per ton. During 1900 it was $45 per ton. Cripple Creek now produces one-fourteenth of the world's annual gold supply. It long ago put Colorado in the front rank of the gold-producing states of this country, and its output alone exceeds that of California, the next state in value of production. Its production has also put the United States in the front rank of gold-producing countries, as Australia was overhauled and passed in the year 1900.

In the district are about 12,000 mining claims and about 500 producing mines. For the year 1900, $6,878,752 in dividends was paid by 47 mining companies, and at least $500,000 more was paid by companies operating on leases. Of this, $1,586,000 was paid by "Stratton's Independence Limited Co.," and $750,000 by the Portland Mining Co. There were six other companies that paid over $200,000 each. The increase in total dividends paid was 67% over that of 1899. The total paid by the mining companies from 1891 to 1900 has been $18,688,158, an average of about 20% of the production.

Nearly all of the mines are located within a circle of hills about five miles in diameter. The richest section is Battle Mountain, just north of Victor. Here is located the Portland mine, the greatest in the district. The Portland Gold Mining Co. owns 183 acres of the most valuable mineral ground in the district, and it is probably the greatest mining corporation of the state. It has a nominal capital of $3,000,000, in $1 shares. These shares now sell for about $3. About 200,000 tons of ore valued at over $10,000,000 had been produced up to Aug. 1, 1901, and the company had paid $3,667,000 in dividends; $3,250,000 was the value of the product for 1900. The main working shaft on the property is down over 1,400 ft. There are over 17 miles of underground workings that reach the network of mineral veins, and the value of the ore in sight is estimated at $20,000,000. During the past year the company has been erecting large reduction works, for treatment by the chlorination process of the ore coming from its mine. These works are just south of Colorado City, and will have a capacity of 300 tons per day.

Stratton's Independence Mine is the most famous of those in the district, and it gave the first great impetus to mining here. This mine was located on July 4, 1891, by W. S. Stratton. Mr. Stratton realized a profit of about $2,500,000 out of a gross production of less than $4,000,000 during the eight years he operated the property. In 1899 he sold it to an English corporation for $10,000,000 cash. Up to Aug. 1, 1901, the new company had declared about $3,500,000 more in dividends. In this, as with many other mines of the district, the richness of the ores seems to increase after great depth is attained. It is intended in the near future to sink the shaft to a depth of 2,500 ft.

Nowhere has there been a more remarkable transformation than made in the past ten years in the Cripple Creek region. From a sparsely settled range for cattle, it has developed into a community of 40,000 to 50,000 souls, with twelve cities and towns. The district is fairly gridironed with railways. The towns are furnished with all the conveniences of modern civilization, and the hills are dotted with buildings equipped with the most expensive machinery for gold mining.

Within the past year more direct connection has been obtained with the outside world by the completion of the Colorado Springs & Cripple Creek District Ry. A very large tourist traffic has been enjoyed by this road, as a large percentage of the tourists visiting Colorado Springs have taken the trip to Cripple Creek, both to see the mining region and the scenery along the railway itself.

ELECTRIC POWER IN CRIPPLE CREEK.—The cost of power to operate the mines here, as in nearly all other mining districts, is a large item in the total cost of operation.

While most of the mines still use steam power, generated on their premises, electric power is used to an increasing extent, and there will be afforded an opportunity for a comparison of the relative merits of the different means of generating and supplying the electric current. Of these, there are three distinct methods so far used:

1. The generation of the current in the immediate vicinity of coal mines, at a much lower altitude than the district, and its long-distance transmission at a high potential to the centers of distribution in the district, the voltage there to be reduced and the current furnished to the different mines.

2. The production of the current within the district itself and the direct supply to the different mines, without the need for any change in the voltage nor the long-distance transmission of the current. To offset this advantage is presented the cost of transportating the coal from the mines, about 30 miles off, over a mountain road to an elevation 4,000 or 5,000 ft. higher.

3. The generation of the current by water power in the mountains near the district, the stepping up of the current and its transmission (for a distance less than one-half that in the first method) to the centers of distribution; there to be stepped down again.

The first method has been tested the longest, through the Colorado Electric Power Co.'s plant, and it will be briefly described. The generating plant is located at Canon City, situated at the mouth of the Canon of the Arkansas River and adjoining the Canon coal fields. The plant is located near the south bank of the river. Coal may be delivered by side track from either of two railroads. The coal mines are south and southeast of town, and coal can be brought from the company's own mines by easy wagon haul.

The main building is 100 × 106 ft., and the transformer building 27 × 72 ft. In the boiler rooom is a battery of four 300-HP. Heine water-tube boilers. In the engine room are three Hamilton-Corliss cross-compound surface condensing engines. The steam pressure is 140 lbs. and the speed is 100 revs. Each engine is direct coupled to a 3-phase, 30-cycle 470-K-W. Westinghouse generator furnishing current at 500 volts. There are two small engines, each operating an exciter at 140 volts. Either of the exciters has capacity enough to furnish current for all three of the generators.

One unit in boilers, pumps and condensers, and one of the three-generator units, are always held in reserve to provide for emergencies. Each generator has its own switchboard panel, and there are complete indicating and measuring appliances. The potential is converted by step-up transformers from 500 to 20,000 volts. The transmission line extends by the most direct route possible from Canon City to the center of the mining district, a distance of a little over 24 miles. The poles are of white cedar and are 30 ft. high.

There are three power wires, one being carried at the top of the poles and the other two at the extremities of a cross-arm. The wires are transposed three times in the length of the line. The line loss in transmission varies from 5 to 10%, according to the load. On brackets below the cross-arm are the two wires of a telephone circuit. These wires are transposed every quarter of a mile. At the central station and at four points on the line are Wurts non-arcing lightning arresters. The transmission line terminates at Station No. 1 on the south slope of Bull Hill and near the high-line electric railway between Victor and Cripple Creek. Here the potential is reduced to 500 volts, at which the current is conveyed to the mines and mills and utilized at 450 volts. Station No. 2 is located on the line of the electric railway on the other side of the summit and 1¼ miles distant from Station No. 1. It has a bank of transformers similar to that in the other sub-station. The two stations are run in parallel.

At Station No. 1, part of the 500-volt current is raised by transformers to 2,500 volts to supply mills some distance away; 6,600-volt transformers are also used for providing current to supplement that used by the Cripple Creek District Ry. (electric) for the supply to its central station, where the alternating current is reduced to a continuous current of 600 volts and used in operating the road.

The Colorado Electric Power Co. now supplies current for lighting a large number of mines, and the power for operating probably 60 mine hoists, several large samplers and mills, and a number of fans and air compressors. The power motors at the different places vary in size from 2 to 100 HP. At the different mines are motors ranging from 5 to 30 HP., operating both geared and friction hoists. The company claims that the use of its power results in a large saving in cost to its customers, as well as a very much greater reliability of service as compared with a steam plant located at the point of use. Coal is worth $1.25 per ton at Canon City, and it costs about $2 per ton to haul it to the mining region, and thence to most of the smaller mines is a wagon haul adding 50 cts. to $2 more.

During the late winter and early spring months, the roads are often almost impassable on account of snow or mud. At times, many of the steam hoists of mines some distance from the railway have to be shut down for a few days because of the impossibility of hauling fuel up the steep roads through the snow and mud. It is claimed that in spite of the hard snow storms during the winter and early spring, and the severe lightning experienced during the summer months, the mines receiving their power from this company have had an uninterrupted supply.

The third method is being used by the Pike's Peak Power Co., which has recently constructed a water and electric power plant having many interesting features.

COLORADO IN GENERAL.—Business in this state was stagnant after the financial crisis of 1893. The closing down of the silver mines, however, resulted in the people turning their attention to gold and other products of the mineral regions, and also to manufacturing and other industries. The output of the gold mines in 1900 was almost $30,000,000, while that of the silver mines was only $12,000,000. Only ten years before, the annual production of silver was several times that of the more precious metal.

The agricultural resources have been greatly developed. The corporate irrigation enterprises, however, have nearly all had the same experience as in other parts of the West, and, with possibly one or two exceptions, have never paid interest on the money put into them. Though they have been beneficial to the state, by reason of the large amounts of outside money expended in construction and in maintenance, and by colonization, the investors in their stocks and bonds have been unwilling benefactors of the public.

During the past two years the raising of the sugar beet and its conversion into sugar have become established industries, and the former promises a solution of the problem of settling the lands under the large canals, whereby the owners of the latter will derive a goodly sum from the sale of their water rights and from the increase in value of their own land under the canals. Both in the Grand River Valley, near Grand Junction, and in the eastern Arkansas valley, the beet sugar business is now well established.

I noticed that on the Union Pacific, from Denver to Kansas City, negroes were exclusively employed as section hands. Some other roads east of Denver may also do this. In most of the northwestern part of this country now, Japs are quite generally employed for section work, and also largely on construction trains and track-laying. They are very intelligent and efficient, having mostly displaced the far inferior Chinese, who were largely employed before.

KANSAS CITY.—From 1886 to the end of 1887, Kansas City and its outlying districts was the scene of about the biggest real estate "boom" that ever occurred on this continent. This stimulated building operations of all kinds, and the rapid growth of the city and many public improvements, together with the extensive and costly cable and elevated railway systems, seemed to justify the belief as to the coming greatness of the place.

For a time the enterprising real estate men threatened to take in about all the territory within an hour's ride by train; but an end was bound to come to this real estate speculation, and when finally the boom collapsed, most of the later buyers were eager to unload—but too late. All lines of business depending on, or intended for, the growth of the city soon became exceedingly dull. Of the many engineers who had found lucrative employment in the different kinds of improvement work, most

were obliged to emigrate, and only a few of the engineering firms have remained.

The collapse of the real estate boom probably did good here in putting things on a normal basis, and there has been a slow but steady advancement in the municipal improvements, and in manufacturing industries.

Beginning with 1889, all municipal work has been conducted by a Board of Public Works.

On account of the sticky clay formation on which Kansas City is built, the paving of the streets as the city has grown has always been one of the essentials, and much more has been expended for this than for any other kind of work; 15 to 18 years ago wooden blocks were almost universally used. Their lack of durability and the unsanitary condition of such pavements was soon recognized, however, and for the past ten years little or no wood paving has been laid. Of the total mileage of pavements in April, 1899, there was 61.1 miles of asphalt; vitrified brick, 27.8; cedar block, 8.5; stone blocks, 2.2; and macadam, 51.9. The average cost per square yard of asphalt pavement has come down during the past ten years from about $2.80 to $2.10; that of brick, from $1.70 to $1.40. Stone block pavement has averaged about $2.75, and macadam has ranged between 42 cts. and $1.05.

On account of having such excellent natural drainage, there have never been any serious problems in constructing a sewer system for the city, nor has the cost been at all large. It must be said, however, that the questions of cleanliness and aesthetics have never appealed strongly to the average Kansas Cityan, and that the assortment of smells coming from the packing-houses and other places reminds one strongly of certain parts of Chicago.

Though one of the objects in creating the Board of Public Works was to separate all public improvements from politics, the experience here, as in Denver, has been that this happy condition has never been reached, though probably there is a good improvement over old conditions.

Kansas City was one of the first cities to have cable traction for street railways. This system was first adopted by San Francisco in 1873, and then by Chicago in 1882. In 1885 the first line in Kansas City, the Ninth St. line, was put in operation. Others soon followed, and in three or four years there were between 30 and 40 miles of cable railway in operation.

After the many points of superiority of electric traction were proven, several of the cable roads were changed to electric. These included one with grades of 8½%. These changes were mostly made between 1894 and 1897, but they are still in progress. The elevated railway, running over into Kansas City, Kan., also had its motive power changed from steam or "dummy" engines to electricity. At the present time there are about 175 miles of single-track street railway. Of this 37 miles (18½ miles double track) are operated by cable. There are many pieces of grade that cannot be overcome by electricity. Particularly in this true on the Ninth St. line. This line first leads from the Union Depot to the main bluffs east of it by means of an iron viaduct with a grade of 18½%. Grades of 10 and 12% are numerous, and one at the business center of town is 14½%. All the horse-car lines have been changed to electric traction. Outside the city, the line to Independence, 10 miles long, has been changed from steam "dummy" to electric. There is also an electric line to Leavenworth, 26 miles distant up the Missouri River.

Salt Lake City, Utah, Dec. 1, 1901. W. P. H.

RATIONAL AND EMPIRICAL FEATURES OF FLOW OF WATER IN PIPES.

(In Engineering News of Oct. 31, Prof. I. P. Church, of the College of Civil Engineering, Cornell University, published an article with the above heading; and upon this article Mr. Clemens Herschel, M. Am. Soc. C. E., made some comments in a personal letter to Prof. Church. This letter of Mr. Herschel, and the reply thereto by Prof. Church, are here given in full, with the consent of the writers.—Ed.)

Prof. I. P. Church, Cornell University, Ithaca, N.Y.

Dear Sir: I have read your article in Engineering News, Oct. 31, 1901, with much interest. But do you not think that the time has come, when the idea of friction of water flowing in a pipe should likewise be relegated to a subordinate position in the consideration of that subject, because [at least, in my opinion] friction is a subordinate element in that form of motion, and the ruling consideration is the impinging of particles of water against the wetted perimeter, and it is the motion of those particles relatively to each other, and not with respect to the wetted perimeter, which causes retardation in the direction of flow of the whole body of water.

For instance, you say: "Strictly, the water nearer the axis of the pipe is moving more rapidly than that further away." Still more strictly, I submit, that this sentence should read: "Strictly, the particles of water nearer the axis of the pipe move more rapidly in line of the axis of the pipe than those further away."

As regards absolute motion in space, I am inclined to think that the particles of water on the periphery move just as fast as those in the axis of the pipe. As to this I want to call your attention to what I say on this subject, on pp. 61-81, of my book called "115 Experiments," etc.; John Wiley & Sons, 1897.

You will recognize how completely I should be ready to object to the article in parenthesis contained in your paper, about the middle of the second column of p. 332, and that I protest against the law of friction being any more a guide than the law of a falling body, in the consideration of this subject. Rather than base the consideration of this subject on either the law of a falling body or on laws of friction, I think it will have to be based on the two together, but both of them overpowered to a large extent by the law of averages as derived from the theory of probabilities, and influenced enormously in the practice of hydraulic engineering by the accidental shapes, forms and conditions of the whole interior surface of the channel under consideration; caused by joints, branches, protuberances, recesses, and what not, such as may be found in every pipe and conduit.

So true is this, that experiments made on the flow of water through a perfect cylinder are of only moderate value for practical application; and experiments made on any one pipe or conduit do not prove general laws, are of but limited application to other pipes and conduits, and are inapplicable to the case of flow through a geometrically perfect pipe or conduit.

Whence a shedding of much ink, and discovery of much knowledge which is not so.

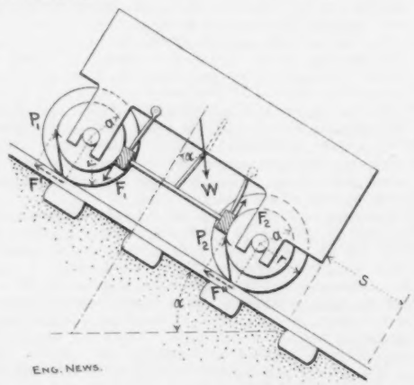
Very truly yours, Clemens Herschel,
Hydraulic Engineer.

No. 2 Wall St., New York, Nov. 2, 1901.

Mr. Clemens Herschel, No. 2 Wall St., New York.

Dear Sir: Having received your letter of the 2d inst., in which attention is called to my employment of the frictional or surface action between the wall of the pipe and the outer surface of the body of flowing water in pipe, in my recent article in Engineering News, I would say that I agree with you perfectly in thinking that the resistance to the acceleration of water having steady flow in a pipe is caused mainly by the relative motions of the particles themselves, that is, by internal "friction;" the eddying motion producing which being kept up by continual impingement against the walls of the pipe, the roughness of which has therefore considerable to do with the limitation of mean velocity. (See the opening sentence in Case II. of my article, foot of second column.)

But this does not conflict with the truth of equations (1), (2) and (3), so long as the intensity of the eddying, etc., is distributed with fair uniformity through the cylinder of water C M of my figure. Though at first sight it might seem as if this quantity called F did not take into account the internal frictional forces, it is to be noted that its value is dependent upon the intensity of that internal action; as may be illustrated in the following problem; where, to render all steps and elements perfectly clear and definite, a collection of only three rigid bodies is taken into consideration, instead of the group of millions of rigid bodies (or water particles) composing the cylinder C M of my figure.



These three rigid bodies move relatively to each other and rub on each other, and are the two pairs of wheels and the car-body, composing a simple railroad car. The axle of each wheel-pair has keyed upon it a drum of radius = a, upon which a brakeshoe can exert pressure, with consequent friction. The radius of rolling rim is r. What relation must hold between the two brake frictions F_1 and F_2 and the other forces acting on the car, when, on given down-grade, a uniform velocity is to be maintained (steady motion)? These other forces are the combined weight, W, of the three bodies; the two pressures P_1 and P_2 of the rails against the wheels respectively; and the normal pressures between the brakeshoes and drum rims and journals and bearings. Neglect axle friction, and "rolling resistance" (crushing down of small protuberances on rail and wheel rim); as also the resistance of the air. In above figure F' and F'' are the components, parallel to rail, of the oblique pressures P_1 and P_2, respectively; and it is to be particularly noted that only when the brakes are in action can P_1 and P_2 be otherwise than perpendicular to the rail (during uniform motion). In other words, the value of the components F' and F'' depend on the amounts of brake frictions F_1 and F_2.

Let F_1 and F_2 now have the proper values for counteracting the acceleration of a velocity already possessed by the car (wheels not skidding) and consider that the car has described a distance s along the incline with uniform speed. Then, applying the principle of work and energy to this collection of rigid bodies, for this range of motion, we note that the aggregate kinetic energy, at the end is equal to that at the beginning; hence the work of gravity $W \cdot s \cdot \sin \alpha$ is entirely expended on the work of external friction $(F_1 + F_2)\, s'$, where s' is the total distance through on the rim of the drum by one brake-shoe. Evidently, since the wheels have not skidded,

$$s' = \frac{a}{r}\, s,$$

so that the equality

$$W\, s \sin \alpha = (F_1 + F_2)\, s'$$

can be written

$$W \cdot \sin \alpha = (F_1 + F_2)\, \frac{a}{r} \qquad (15)$$

which is the relation desired.

[No work is done either by, or upon, the forces P_1 and P_2, since the point of application of each is at rest while the force is acting at that point of wheel.]

Now let us try another method. If we consider each of the three rigid bodies separately, and put the algebraic sum of the components parallel to rail of all the forces acting on each of these bodies equal to zero (since each has a uniform motion), and add these three equations, member to member, all mutual actions between these bodies cancel out, and we have left

$$W \sin \alpha - F' - F'' = 0;$$

i. e.,

$$W \sin \alpha = F' + F''. \qquad (16)$$

But, since the rotary motion of each wheel-pair is uniform, about an axis passing through its center of mass, we have, by moments, about that axis $F'\, r = F_1\, a$; and $F''\, r = F_2\, a$; which substituted in equation (16) gives the same result

$$W \sin \alpha = (F_1 + F_2)\, \frac{a}{r}$$

that was derived by the first method.

It is thus seen that while the internal frictions F_1 and F_2 are not directly represented in equation (16) their influence is fully operative, since the values of F' and F'' depend on F_1 and F_2; and equation (16) is consistent with (15), and derivable from it. That is, equations (15) and (16) are both right.

Equation (16) corresponds to equation (1) of my article (on which equation (3) is based) and it would make no difference in equation (3) if the liquid close to the wall of the pipe were not moving at all (a very viscous fluid, e. g.); the force F of equation (3) would be just as real. This would make the case of the liquid correspond still more closely to that of the railroad car above, since the point of the wheel that is momentarily in contact with the rail is not moving along the latter.

To pursue further the analogy of the railroad car, let us suppose an automatic speed-governor to be attached to the car, of such construction that the brake-friction augments with increasing speed; so that when the velocity became (say) 10 miles per hour the brake-friction would reach just the proper value to prevent further acceleration (for the given slope). If, then, the car be started from a state of rest down the grade, the speed would continue to increase until a value of 10 miles per hour was reached, after which the motion would be uniform (steady motion) at that speed. (This is what happens to the water in the pipe in my figure after the pipe is unstopped.) If the grade were made steeper, the motion of the car might not become "steady" until a speed of 15 miles per hour had been reached, since a new and greater value for brake-friction will now be necessary. The relation between the V of steady motion and the grade in successive cases, the grade being changed each time, would depend entirely upon the construction of the governor, and could be made

$$V = \text{const.} \times \sin^2 \alpha\ ;$$

or,

$$V = \text{const.} \sqrt{\sin \alpha}\ ;$$

or,

$$V = \text{const.} \, [\sin \alpha]^{1/2};$$

or anything else according to the fancy of the designer; and the relation of V to F_1 and F_2 (or to F' and F'') could be called the law of friction. (The law $v = \sqrt{2gh}$ of a falling body would have nothing to do with the relation of V to F_1 and F_2.)

Following this analogue, the case of water flowing through the pipe in my article could be stated as follows: Nature has provided the water with brakes and an internal speed-governor by whose action, after the pipe is unstopped, the motion will continue to be accelerated until a definite speed (speed of steady flow) is attained; after which no further acceleration takes place. She has kept the law of this speed-governor [relation of V to F_1 and F_2; or, finally of V to sin α, or S] a secret and we can only discover it by experiment.

I would have no objection to changing my statement at the foot of first column so as to make it read, as you suggest; "Strictly the particles of water nearer the axis

of the [illegible] move more rapidly, in the line of the axis of the pipe, than those further away." As regards your criticism of the bracket in middle of the second column, it may be said that since in the derivation of equations (1), (2) and (3), the reader might gain the impression that the cylinder of water C M is being treated as a single rigid body, I added the bracket to indicate that in the case of the particular relative motions there described (which is, of course, nearer the truth than the supposition of entire rigidity) equation (3) is still true; and, if space had permitted, I would have liked to add to it (inview of the statement in the first five lines of Case II.) by saying: "It would be still nearer the truth to consider that each particle of the fluid describes eddying curves among its fellows (see statement in Case II. below), creating internal friction; but if these internal motions are of fairly even character throughout the cylinder C M, the truth of equation (3) will not be impaired."

Personally, I see no objection to applying the adjective "frictional" to the resistance due to the internal commotion and agitation of the water. When we rub a paving brick on another the resistance is called frictional, and heat is produced. When we place a number of such bricks in a "rattler," and by the rotation of the latter cause them to rub and scrape on each other, the energy so spent we say has been spent on friction, and the bricks are warmed in the operation. When Joule and Rowland employed paddles to churn the water in a vessel and thus determined the mechanical equivalent of heat, the temperature of the water was raised and the energy of their source of power may very properly, it seems to me, be said to have been spent in the overcoming of "fluid friction." I see, therefore, no objection to saying that in the case of steady flow of water in a pipe the work of gravity has been spent against fluid friction, both external and internal (except, of course, the small amount represented in the kinetic energy of the jet at end of pipe).

When a discussion is carried on in purely general terms the result is often very unsatisfactory, since the parties to the discussion may use the same word in different senses and misunderstand each other (witness the word "friction" in the present instance), and hence achieve the "shedding of much ink" with little progress toward an agreement. For this reason I have taken the liberty, at the risk of wearying you, of presenting the specific case of the railroad car, as a very fair analogy and as presenting a case where the principles of mechanics can be applied in a perfectly rigorous manner, admitting of no misunderstanding.

Thinking that possibly you may never have seen Manning's original paper I enclose a blueprint containing a table, etc., copied from it. I have the impression that the "Transactions of the Institute of Civil Engineers of Ireland," is not well represented in the libraries, public or private, of this country.

Very sincerely yours, I. P. Church.

Ithaca, N. Y., Nov. 7, 1901.

BOILER EXPLOSION AT THE WORKS OF THE PENBERTHY INJECTOR CO., DETROIT, MICH.

On the morning of Nov. 26, 1901, a boiler at the works of the Penberthy Injector Co., at Detroit, Mich., exploded, totally wrecking the building in

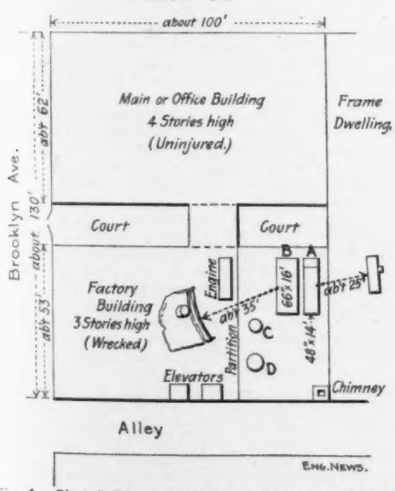


Fig. 1. Sketch Plan of Works of Penberthy Injector Co., Detroit, Mich.

which it was situated, and causing the death of about 30 people, besides injuring a large number of others. The accident was briefly noted in our issue of Dec. 5; we have since then been able to secure some more detailed information in regard to the disaster.

The Penberthy Injector Co., manufacturing injectors and other steam specialties, occupied two brick buildings, standing on a lot about 100 × 130 ft. at the intersection of Abbott St. and Brooklyn Ave. The main building, four stories in height, occupying the corner of the lot, was used for offices, storerooms, tool and core shop, etc. The other building, a three-story structure occupying the rear half of the lot on Brooklyn Ave., was separated from the main building by a narrow courtyard or alley. On the top floor was the brass foundry, on the second floor the machine shop or finishing room, and on the ground floor were the boiler, engine and testing rooms. This building was the one totally destroyed by the explosion.

FIG. 2. VIEW OF SITE OF WRECKED BUILDING OF PENBERTHY INJECTOR CO.

A rough sketch of the ground plan of the works is shown in Fig. 1. The location of the boilers on the first floor of the wrecked building is approximately indicated in the sketch. There were four boilers, marked A, B, C, and D on the plan. Two of them, A and B, were horizontal; the other two, C and D, vertical boilers. The latter two were used only for testing finished injectors. Boilers A and B furnished steam for power purposes and for heating the plant; they were never used for testing injectors.

The boiler that exploded was the one marked B, the larger of the two horizontal boilers. It was 66 ins. in diameter, 16 ft. long, and had 64 four-inch tubes; the shell was of steel ⅜-in. thick, the heads of ½-in. steel. The shell was made of two plates as long as the boiler; the two longitudinal seams were lapjointed and double-riveted. The boiler was at least eight years old; at its last inspection it was allowed 100 lbs. per sq. in. pressure, and it has been stated that the safety valve was set for 95 lbs.

Boiler A was 48 ins. in diameter and 14 ft. long, and, like the larger one, it had 64 tubes. The shell was of ½-in. steel, the heads of ⅜-in. steel. In general construction the two boilers A and B were similar. They were each fitted with two water columns and a low-water alarm of the Penberthy make.

At 9.30 a. m. on Nov. 26, boiler B exploded without warning, causing the entire collapse of the building in which it was located. The main, or office building, was practically uninjured. The heavily-loaded upper floors of the factory building fell to the ground, carrying down with them the walls and the roof. The ruins started to burn immediately after the explosion, considerably delaying the work of rescue of those caught in the debris.

A view of the site after most of the wreckage except that pertaining to the boilers had been cleared away is shown in Fig. 2. A nearer view of the boiler that failed is given by Fig. 3. As indicated in the ground plan, Fig. 1, this boiler was thrown about 35 ft. from its setting toward the center of the building, passing through the partition between boiler and engine rooms. Boiler A was thrown about 25 ft. in an opposite direction.

Immediately after the explosion the premises were taken charge of by the police, under instructions from the prosecuting attorney; the latter further engaged Prof. M. E. Cooley, M. Am. Soc. M. E., of the University of Michigan, to investigate the accident. The Penberthy Injector Co. retained Mr. Anton Ekstrom, of Detroit, and Prof. R. C. Carpenter, of Sibley College, Cornell University, to make an examination of the wreck. All others have been excluded from the site by the police, and it has, therefore, been impossible for unauthorized persons to make a closer examination of the remains of the exploded boiler. As near as could be noted, however, it appears that the boiler gave way at one of the two longitudinal seams, either just below or just above the supporting brackets. Test strips have been cut from the shell at various points in order to determine the quality of the steel. A newspaper item just received states that the cause of the explosion has been practically settled on; it is hinted that there was a defective spot in the boiler, and that this was located next the brick wall (setting) where even an inspection would not reveal its existence.

The man who had charge of the horizontal boilers is said to have been a most conscientious and careful man. His regular fireman was absent through illness on the day of the accident; it is not stated how the firing was arranged for on that day. We are informed that the boilers were well cared for, being cleaned out and examined once a month. The last recorded inspection of the boiler plant is dated July 5 and 17, 1901; the pressure at that time allowed by the inspector on the boiler that failed was 100 lbs.

The damage to the plant will probably reach $100,000, of which about $70,000 is covered by insurance. The company also carried accident insurance on its employees.

President Johnson, of the Penberthy Injector Co. informs us that the company has secured new quarters in the neighborhood of the wrecked factory, and is making arrangements to resume work as rapidly as possible.

SWAMP DRAINAGE FOR THE IMPROVEMENT OF PUBLIC WATER SUPPLIES.

At the monthly meeting of the New England Water-Works Association, at Boston, on Dec. 11, Mr. Edward S. Larned, Division Engineer of the Metropolitan Water-Works, read a paper on "Swamp Drainage for Water-Shed Improvement."

The full paper will be published in the "Journal" of the association. The following is a brief abstract of the paper and discussion:

As is well known, water standing in swamps takes up a large amount of organic matter, and at the same time acquires a large amount of color. It has been found that, at least in the waters of Massachusetts, the amount of color of swamp waters is practically a direct index of the amount and condition of the organic matter.

The purpose of the work described is to intercept the water from the upland and carry it directly to the reservoirs, as well as to make it impossible for water to stand long in the swamps. The improvement has been made in all cases by ditches having board bottoms and paved slopes, the width of the bottom being uniformly 1 ft., while the depth is made sufficient to take the necessary quantity of water. The slope has usually been about 0.1%. In all, about 24.5 miles of such ditch have been constructed within the Sudbury watershed, of which about nine miles, draining five swamps, were built by Mr. Larned, at an average cost, exclusive of engineering, of 28.3 cts. per ft. One result of this work has been to make what was formerly useless land into suitable land for meadow, and by explaining this to owners it was found possible to build these nine miles of ditch, entirely through private land, at a total cost for land damage of $49.82.

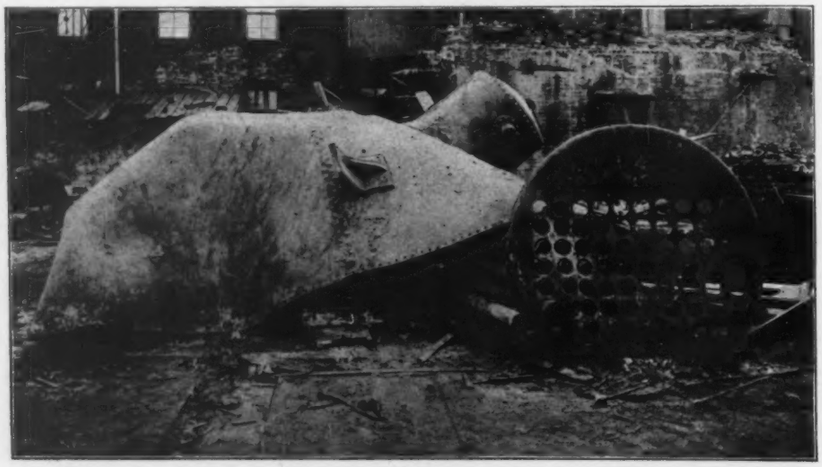


FIG. 3. WRECKED BOILER OF PENBERTHY INJECTOR CO.

Observations of color of the water have been taken at points on the brooks leading from the various swamps, both before and after ditching, usually once a month. From these observations, normal colors were computed by multiplying each color by the yield of the watershed for the month in which it was observed, and dividing the sum of the products by the sum of the multipliers. A comparison of normal colors before and after ditching shows a removal of color of from 14 to 48% in the various swamps. Mr. Larned considered that on the whole, an improvement of at least 30% in color could usually be obtained by such ditching.

In the discussion, Mr. Horatio N. Parker, Biologist Metropolitan Water-Works, noted that the swamps are also breeding places for microscopic organisms, which in freshets are washed down into the reservoirs, and may give rise to considerable trouble. Mr. W. H. Richards, Superintendent of the New London water-works, said that about ten years ago he had carried out a similar work, and although they had no numerical determinations of the color, the improvement was very notable. In his case, the topography was such that he could not only intercept the upland water and convey it to the reservoir direct, but also drain the swamp away from the reservoir into an adjoining watershed. Mr. C. W. Sherman, Assistant Engineer, Metropolitan Water-Works, called attention to the fact that most of the swamps mentioned by Mr. Larned were near the borders of the watershed, while the color observations were made at points near the reservoirs, and consequently represented the color of the swamp water after dilution with considerable upland water—the latter, of course, not being affected by the ditching. In the case, therefore, where the examinations showed but 14% improvement, the actual improvement at the outlet of the swamp was probably 30 to 40%.

THE CHILEAN TRANSANDINE RAILWAY, for the construction of which W. R. Grace & Co., of New York, has lately obtained a concession, would connect the existing railways on the eastern and western sides of the Andes and put Buenos Ayres and Valparaiso in communication by rail. At the present time there is a gap of only 50 miles between the Argentine Great Western and Buenos Ayres & Pacific system, on the east side, and the Valparaiso and Santiago systems on the west. The engineering difficulties in this pass, at a high elevation, are enormous, and much tunneling will be required. In 1872 a concession for building this link was granted to Clark Bros., who commenced work in 1889; and, after expending about $2,000,000 they abandoned the work, owing to political troubles and financial uncertainty on the part of the government. In 1897 the present company was formed, and all parties interested have now relinquished all rights to the American syndicate. With this link built a railway 900 miles long will connect the capitals of Argentina and Chile and save a sea voyage of 3,000 miles. The fact that Chile will only control about 100 miles of this route is said to be at the bottom of some of the present trouble between these two South American states.

AN ELECTRIC COAL-HANDLING PLANT, in New York harbor, equipped by the C. W. Hunt Co., of West New Brighton, N. Y., has furnished figures for the actual cost of transferring coal from boats to the stock pile. The plant includes an electric hoist for lifting the coal in ½-ton tubs from the canal boat; and an automatic car which carries the coal on a trestle to the stock pile. The total equipment cost $2,800; and the actual cost of transferring the coal is 7¼ cts. per ton, including interest and depreciation. With the old plant, which this one superseded, this cost was 17¾ cts. per ton. The new plant has a capacity of 200 tons per day; and the purchased electric power costs less than 7 mills per ton of coal hoisted. Two men operate the plant.

THE SHIPMENT OF IRON ORE from the Lake Superior region to December 1, amounted to 20,000,926 tons, and the total shipment for the year will doubtless reach 20,500,000 tons, the highest on record. The Fayal Mine alone shipped 1,656,838 tons.

UNDERGROUND TEMPERATURES have been investigated, in 1899-1900, at 44 shafts of the Ruhr coal region, in Germany. This was done by drilling a hole 6 ft. 6½ ins. deep into the rock in the side of the shaft and placing in it a thermometer protected from the air-temperature of the shaft; the thermometers were left two hours before reading. The depths tested ranged from 320 to 2,545 ft. At 80 ft. seasonal variations of temperature became inappreciable; and at this depth the temperature was constant at 45° F. through the year. The temperature, as an average, increased about 1° F. for each 51 ft. of depth, but this rate seemed to diminish somewhat as the depth increased. A single record of 102.2° F. at a depth of 2,223 ft. was ascribed to the supposed proximity of a hot spring.

THE FUTURE OF THE WITWATERSRAND GOLD FIELDS.*

By John Hays Hammond, M. Am. Inst. M. E.†

During the eight months ending in August, 1898, after which the commencement of active hostilities interfered with the active working of the mines, the Witwatersrand produced £12,485,032 sterling. At this rate, the year's production would have been £18,727,548. As a matter of fact, it would have amounted to some 20 millions sterling, by reason of the progressive increase in the monthly production already shown during that year. Of this output 71% was derived from what is known as the central section, extending about 1.5 miles west and about 8 miles east of Johannesburg; and 24% was derived from the deep-level properties within that section. The total gold product of the Witwatersrand was 25.5% of that of the entire world. Notwithstanding the increased production of gold elsewhere, this ratio would have been maintained had mining operations not been [illegible] by the South African war. Within one year [illegible] sumption of mining operations, an output [illegible] rate of over 20 millions sterling annually [illegible] ably estimated; and this rate of production [illegible] increased, partly by the increase in the crush[illegible] some of the companies, but more especially [illegible] ing of many of the deep-level properties [illegible] reach the producing stage. Within the next [illegible] years the annual gold production from the [illegible] may reach 25 millions sterling. Beyond this [illegible] should be a further increase, the amount of [illegible] impossible to estimate. In from six to eight [illegible] of the important gold producers among the [illegible] panies will fall out of line, by reason of the [illegible] their mining areas. To what extent this [illegible] counterbalanced by increased yield in the [illegible] properties cannot be as yet determined. [illegible] upon the policy adopted by the larger compa[illegible] these properties.

In the reliability of its ore-bearing formation the Rand is unique in the history of gold mining; but in the minds of many an exaggerated importance is attached to the persistency of payable ore bodies in strike and in dip. There is indeed considerable fluctuation in the value of the ore within the same reef, even within short distances; but a remarkably even grade of ore has been maintained since the inception of the industry. Where there has been an apparent falling off in yield per ton during any year, the fact is to be attributed rather to the working of lower grade ores, made possible by improved economic conditions, than to a depreciation in the ore values of the reefs themselves.

The results of the developments in the deep-level areas have been so satisfactory as to engender a certain recklessness on the part of mining companies owning very deep reefs. The exploitation of certain of these areas is not regarded by conservative engineers as at present justified, in view of the large intervening tracts of undetermined value which separate mines in operation from the site of proposed mining upon these very deep-level areas. To what extent mining can be carried on in depth in the Transvaal is a most interesting and important problem. The conditions there are certainly most favorable for mining at great depth. From present indications the influx of excessive quantities of water is not to be apprehended. In respect to temperature, the district is especially fortunate, in that the increment of temperature with depth thus far observed has been abnormally low. In the case of the Robinson Deep mine, it is about 1° F. for 212 ft. of vertical depth. With the exception of the additional costs of haulage, pumping and ventilation, there are no factors operating against mining on the Witwatersrand to a depth of at least 8,000 ft. vertically. These costs will not afford any insuperable obstacle to profitable mining, provided, of course, the geological character of the deposit is not adversely changed. So reliable is the formation, from a geological point of view, as regards its mining potentialities, that engineers have felt justified in assuming the existence of payable ore at depths of 1,000 ft. vertically and upwards beyond the extent in depth of any mining operations. Thus far the results of actual operations upon these areas have justified their position. It is estimated that for every mile in length along the course of the reefs, down to a vertical depth of 1,000 ft. for the dip of these reefs, gold to the value of about £10,000,000 will be extracted. This is a conservative estimate—at least as applied to the central section of the Rand. If we assume these conditions to obtain to a depth of 6,000 ft. vertically, we have the enormous sum of £60,000,000 for each mile in length. It is not unreasonable to suppose that these conditions will be maintained along most of the central section, say for a distance of 10 miles, in which case we would have an auriferous area, within practicable mining depths, containing upwards of £600,000,000 value of gold.

It is less safe to make any prediction of the gold product to be expected from the east and west sections; but it is perfectly safe to say that the output of these sections would very greatly augment the amount I have named. Messrs. Hatch and Chalmers, well-known engineers of extensive South African experience, compute the available gold from these portions of the Rand at £200,000,000.*

It is impossible to predict with any accuracy the duration of mining in the Witwatersrand district by reason, especially, of the indeterminate factor of the rate at which exploitation will be carried on. It may be observed, however, that the tendency is to exploit the auriferous areas as rapidly as possible, and that engineering methods are all adopted with that end in view. If the exploitation of the deeper levels is not delayed pending the proving of the ground lying above, but is carried on concurrently with the exploitation of the higher horizons of the reefs, the industrial life of the district will, of course, be corre-

*From a paper on "Gold Mining in the Transvaal," read before the American Institute of Mining Engineers.

†Consulting Engineer, 43 Threadneedle St., London.

*The magnitude of these figures can only be appreciated by comparison. According to Soetbeer, the total gold production of the world for 396 years, from the discovery of America to the year 1888, was £1,602,000,000, or only about double the amount of gold which Mr. Hammond estimates as existing in the Witwatersrand. The total world's stock of gold in 1890, according to Mulhall, was £1,235,000,000.—Ed. Eng. News.

spondingly shortened. The working of lower-grade ores, made possible by improved economic conditions or other circumstances, would tend to increased longevity of the industry. But were I called upon to express an opinion I would estimate the future duration of profitable operations on a large scale in the district at less, rather than more than 25 years.

The future looks from all points of view encouraging. We may reasonably anticipate important improvements in economic conditions as the result of the establishment of a better government. I believe that, as the result of economic reforms, there will be an ultimate saving of 6s. per ton of ore treated, as compared with the conditions under which mining has been carried on under the government of the late South African Republic. For the tonnage of ore crushed in 1898, this would result in an increase of annual dividends of £2,199,405.

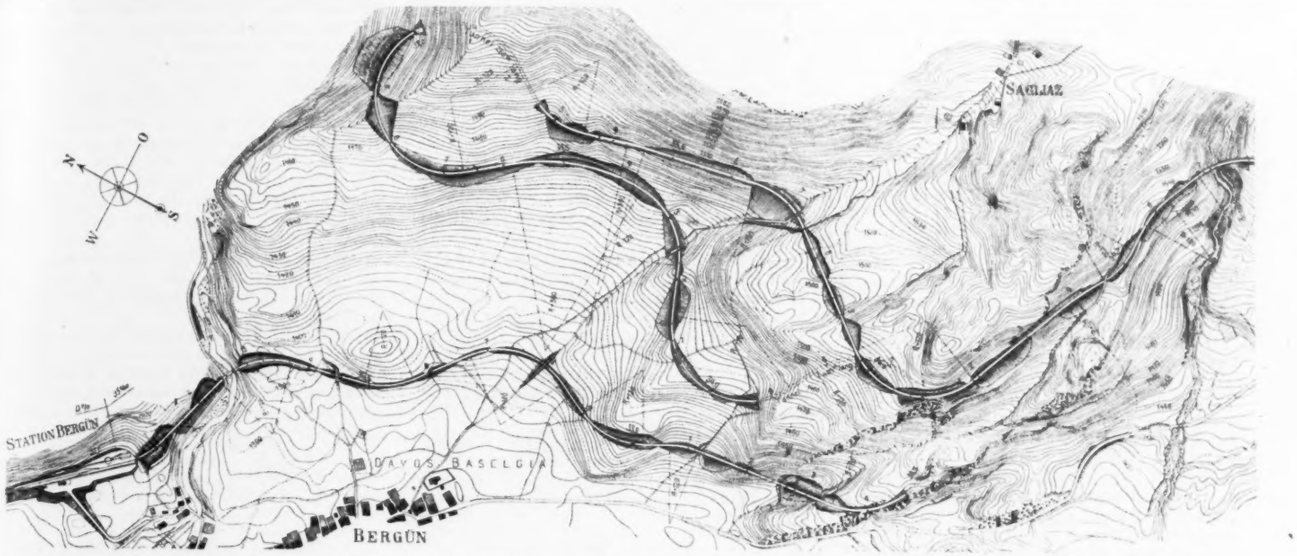


FIG. 1. CONTOUR MAP OF LOCATION NEAR BERGUN, ALBULA BRANCH OF THE RHAETIAN RAILWAYS, CANTON GRAUBUNDEN, SWITZERLAND.

DIFFICULT MOUNTAIN RAILWAY CONSTRUCTION IN SWITZERLAND.

The canton of Graubünden, in the southeastern part of Switzerland, is at present constructing two new lines of railway, aided by a subsidy from the Swiss federal government. These lines, one from Reichenau to Ilanz, with a length of 12 miles, the other from Thusis to St. Moritz, with a length of 39 miles, connect with the existing railway from Chur to Thusis. The longer and much the more interesting of these two lines connects Thusis, lying on the Albula River, a tributary of the Upper Rhine, with St. Moritz, on a lake of the same name at the headwaters of the Inn, an important river tributary to the Danube. It thus crosses the watershed between the Upper Rhine and the Inn, passing through the divide at the Albula pass (about 23 miles east of the famous Splügen pass), by means of a tunnel nearly four miles long. On the southern, or Inn side, of this tunnel, the further location of the line is comparatively simple; on the northern, or Rhine side, it is, however, most difficult, involving a number of compound loops, mostly in tunnel, and numerous other tunnels, bridges, etc. The totals for the whole line from Thusis to St. Moritz are 16 kilos. (10 miles) in tunnel, and 2.7 kilos. (1.7 miles) on viaduct, or 26% and 4½% of the total length of line, respectively. Altogether, the line presents a sum of difficulties in location and construction that make it worthy of a short description.

The railway has a gage of 1 m. = 3.28 ft., and is laid out single track. It is located on a maximum grade of 3.5%. The rails used will weigh 50 lbs. per yd. on grades of 2.5% or less; for heavier grades, 55-lb. rails will be used. The crossties will be of mild steel, and will weigh 80 lbs. each. In the long Albula tunnel, however, treated oak ties will be used, following the results of experience in the St. Gotthard and Arlberg tunnels.

From Thusis to Tiefenkastel, 7.8 miles, may be said to be the heaviest section of the line. It lies in tunnel for 33%, and on viaducts for 15% of its length; the maximum grade is 2.5%. The only steel bridge of the line, a 262-ft. deck span over the Rhine at Thusis, occurs on this section. All other bridges are stone arch viaducts; the largest is at Solis, 490 ft. in length, with a central arch span of semicircular profile, 131 ft. in the clear. The cost of the roadbed to subgrade on this section is $89,000 per mile.

This heavy section is followed by a simpler portion of line, extending to Filisur. It includes, however, two notable viaducts. The first of these has a length of 460 ft., and a height of about 115 ft.; it is located on a curve of 394 ft. radius, with a grade of 2.5%. The second, even more unusual in dimensions, is shown in Fig. 3. It is located on a curve in the alinement of 100 m. (328 ft.) radius, on a grade of 2.5%, reduced on account of curvature to 2.0%; it has six arch spans, each 20 m. (65.6 ft.) in the clear, and the highest point of the track is 213 ft. above water level.

Passing off this remarkable bridge, the line immediately plunges into tunnel, continuing for 700 ft. Just beyond this is the station of Filisur, where future connection is planned for a line to be built to Davos, to connect with the existing branch of the Rhaetian line, terminating there. At Filisur begins the maximum grade of 3.5%, reduced to 3.0% in long tunnels. To reach the next station, Bergün, on this grade, a length of 4,000 ft. had to be interpolated into the natural location by means of a loop. This loop was, after mature considera-

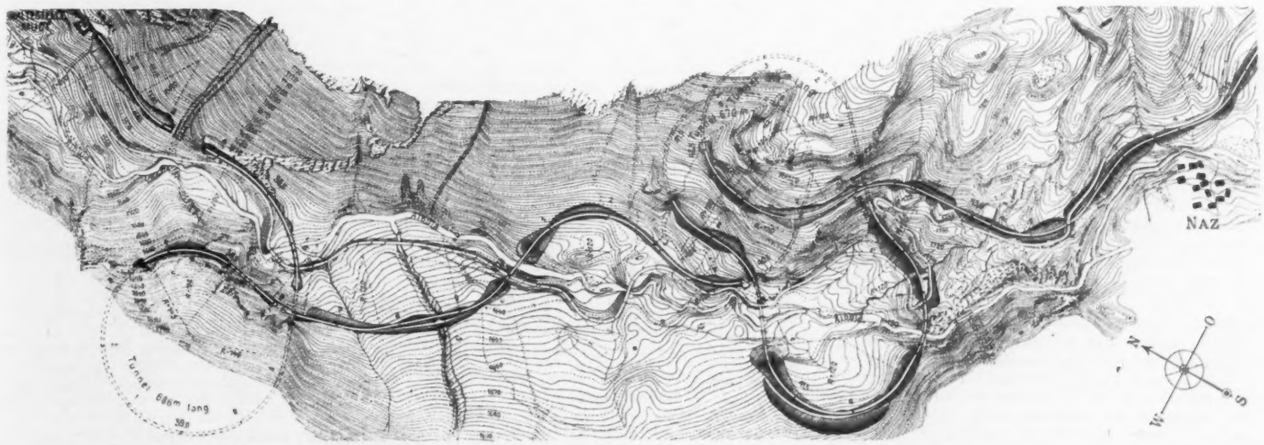


FIG. 2. CONTOUR MAP OF LOCATION AT COMPOUND LOOP, NEAR MUOT.

tion, laid down just beyond Filisur, with a length of tunnel of 2,400 ft. Every other location possible would have necessitated the whole loop development being in tunnel. As it is, the section from Filisur to Bergün lies in tunnel for 20% of its length. The cost to subgrade in this section, including a turnout and siding, is $74,000 per mile.

A similar development by means of loops became necessary between Bergün and Preda, the latter station being at the northern end of the Albula tunnel. The distance to be interpolated here

amounted to 3.4 miles and the problem was therefore of sufficient importance to warrant detailed study. The final solution accomplishes the object in two stages, with a double loop just beyond Bergün, and a complex multiple loop south of the flag-station Muot. The two sections are shown, together with adjacent topography, in Figs. 1 and 2, which will explain themselves. The cost per mile for this section is about the same as for the preceding, $74,000.

From Spinas, at the southern end of the Albula tunnel, the line is in comparatively easy country.

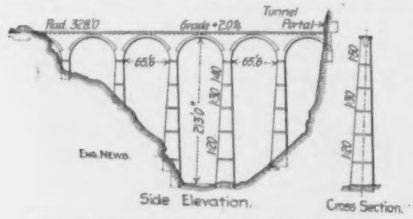


Fig. 3. Elevation of Landwasser Viaduct.

For 2.5 miles it follows down the valley of Bevers, running on high embankment near the middle of the rather broad, flat valley bottom to avoid the several avalanche paths on the side slopes. The remaining distance of 5 miles to St. Moritz the line goes up the valley of the Inn, overcoming the difficulties presented by the Inn gorge by means of two tunnels aggregating 2,000 ft. in length. The average cost to subgrade from Spinas to St. Moritz is only $23,000.

In reference to danger from avalanches it may be said that this formed an important consideration in location at many points of the line. Their known tracks were avoided where possible; in other cases masonry "avalanche galleries," i. e., tunnels only partly in excavation and with sloping roof, were constructed to protect the line. Halfway between Bergün and Preda, at a particularly dangerous point, works designed to prevent future falls and slides will be executed in co-operation with the Swiss federal government. Where trouble from accumulations of snow were to be apprehended, as for instance in the stretch from Bergün to Preda, the line was located as much as possible on high embankment; in cuts the ditches were made of special depth, often as much as 6 ft., to minimize the possibility of obstruction.

THE ALBULA TUNNEL.—The Albula tunnel is the largest single piece of construction connected with the line. It is located on a tangent, with grades as shown in the profile, Fig. 4. The total length of the tunnel is 5,866 m. (19,240 ft.). Preda is situated in elevation 1,792 m. (5,878 ft.), and Spinas in elevation 1,818 m. (5,963 ft.) above sea level. The line rises on a grade of 1% from Preda to about the middle of the tunnel, then down on a 0.2% grade to Spinas.

Work was started, even before the triangulation notes had been reduced, by prolonging the line from a point which it was possible to set in the vertical plane of the tunnel axis on the peak of Giumels. The north heading, at Preda, was started on Oct. 15, 1898; the south, or Spinas heading, on Nov. 1 of the same year, both by the railway direction itself, in order that the work be not held back by delay in awarding the contract, which was not let until Jan. 16, 1899.

The illustration, Fig. 5, represents typical cross-sections adopted for this tunnel. It is worth noting that the clear height here is 1 ft. more than that adopted for the other tunnels of the line, and the width at springing 8 ins. greater than the corresponding dimension for the other tunnels. The tunnel lies mostly in a compact granite (14,000 ft.), and in calcareous slate and shale (3,600 ft.). At both portals large amounts of water were encountered, the trouble from this cause continuing on the north side for a distance of 3,963 ft. from the portal, where the Casanna slate was reached. At 3,300 ft. a source of water with a flow of 11 cu. ft. per sec. was tapped, and although this quantity went down to 7 cu. ft., it continued to hamper the work on account of its low temperature of 43° F., which made the labor very inefficient. At 3,600 ft. another difficulty was encountered in the form of a soft, cellular wacke, which softened under the action of water to such a degree that drilling had to be discontinued, and a narrow, heavily-timbered heading pushed forward, following directly with masonry lining.

Brandt hydraulic drills are used at both ends of the tunnel. In the north heading, the first nine months averaged only 295 ft. per month; this low figure is explained in part by the fact that at many points the rock was so loose and seamy as to require immediate lining with masonry to secure the work. In the south heading machine drilling was started in October, 1900, at 1,060 ft., in granite. An average monthly rate of progress of 370 ft. was reached, the figure for May, 1901, being 426 ft. The granite encountered here is extremely hard, with occasional heavy quartz veins. Generally the rock is very solid, but many fissured and seamy portions have been met. The amount of explosive required in the heading of 75 sq. ft. section is about 17 lbs. per lin. ft., ten holes being drilled as a rule. When explosive gelatine is used, the drill holes are carried to a depth of about 5 ft.

Since April of this year the management of the Rhaetian railways is again in charge of the tunnel construction. The finished cost of the tunnel will be about $1,150,000, or nearly $60 per lin. ft.

The total cost to subgrade of the whole line will be $3,130,000, equivalent to an average cost of about $80,000 per mile. The average cost, excluding the Albula tunnel, will be about $56,000 per mile.

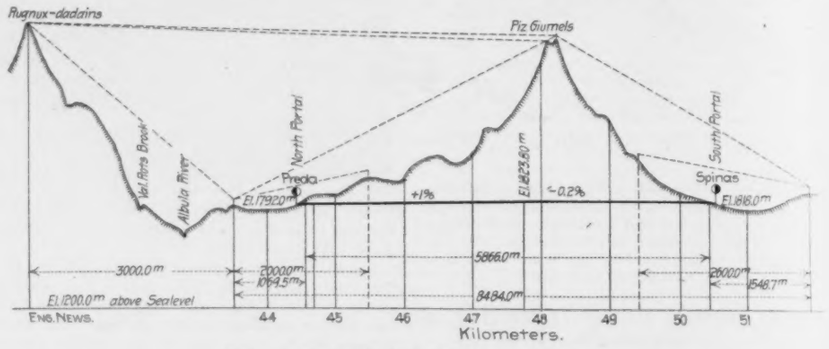


FIG. 4. PROFILE OF ALBULA TUNNEL.

The report for September on the progress of the Albula tunnel has just been published. According to this, the total advance of the headings aggregates 10,170 ft. The progress during the month of September was 558 ft. for the south heading, and 453 ft. for the north heading, a total advance of 1,011 ft. The number of men employed on the work was a daily average of 805, of whom 454 were employed on the south end and 351 on the north end. Both headings are now in granite, that on the south side being the coarser grained of the two, and at the same time considerably the harder. Based on this rate of progress, the headings should meet about the beginning of July, 1902. It is expected that the road will be opened at the beginning of the season of 1903.

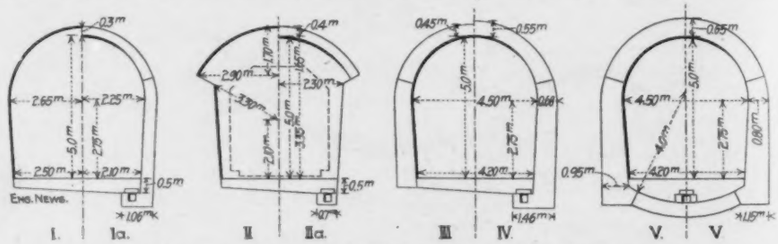


FIG. 5. TYPICAL CROSS-SECTIONS, ALBULA TUNNEL.

THE NEW GARBAGE REDUCTION WORKS AT BUFFALO, N. Y.

A new garbage reduction plant has been under construction at Buffalo, N. Y., during the current year, to replace one which was badly damaged by fire on Oct. 1, 1900. Through the courtesy of Col. Jas. N. McArthur, Treasurer of the works, we are enabled to present some notes regarding the new plant, taken by a member of the editorial staff of this journal during a visit to the plant on Sept. 28.

In our issue of Nov. 1, 1894, we reviewed the history of improved means of garbage disposal at Buffalo up to that date, and described the Merz garbage reduction works as they then stood. In 1896 the plant was rebuilt to conform with the improved Merz system.

The amount of garbage being handled in the latter part of Sept, 1901, averaged 125 tons per day for six days in the week. Deliveries are made both night and day, except Sunday.

The garbage is delivered to the works in wagons which have a capacity of 4 to 5 tons each. Large wagons are used on account of the long haul. The wagons are hauled up an incline onto a platform about 10 ft. above the ground and there dumped into a hopper. The garbage is thrown, by hand, from the hopper onto a conveyor, and from the latter the cans are picked out.

The conveyor dumps the garbage into driers. There are 18 in use at present, giving a daily capacity of 150 tons. Six driers will be added next year.

From the driers the garbage goes to four extractors, in which the Merz improved system of removing the grease by naphtha is used. Four grease separators and condensers are used for securing the grease and recovering the naphtha. The grease is barreled as it comes from the separators.

The tankage is redried (or will be when the plant is completed), then ground and screened, and finally sold as a fertilizer base.

Exhaust fans remove gases from the plant for treatment by heat and condensation.

There are four 125-HP. (nominal) boilers, which were uninjured by the fire of 1900; two 75-HP. (nominal) horizontal engines, from the Erie City Iron Works; an independent electric lighting plant; and the necessary pumps for water and grease. The main building, which is new, is 38 × 160 ft. in plan, two stories high, and is built of wood.

We are informed by Mr. Wm. J. Hillery, Superintendent of the Bureau of Streets, that the present contract for garbage disposal calls for a yearly payment of $15,840. From other sources we have learned that the contract runs for five years from June 18, 1898; also that the present contract was originally awarded to Grattan & Jennings, who assigned it to the Baynes Garbage Reduction Works. It is interesting to note that the latter company bid $44,500 a year for the work.